

# DATA FUSION/INTEGRATION OF HIGH AND MEDIUM RESOLUTION IMAGERY FOR CROP ANALYSIS

## **Iraq Operational Agricultural Monitoring Project:**

United States Department of Agriculture (USDA)

Foreign Agricultural Service (FAS)

Office of Global Analysis (OGA)

***International Production Assessment (IPA)*** Division



**Presenter:**  
**J. Edward Kunz, GISP**  
Geospatial Program Manager  
ASRC Management Services

**Sean Griffin**  
Remote Sensing Crop Analyst  
Supporting USDA/FAS/OGA/IPAD



Photo by Dr. Curt Reynolds



# Iraq Operational Agricultural Monitoring Project

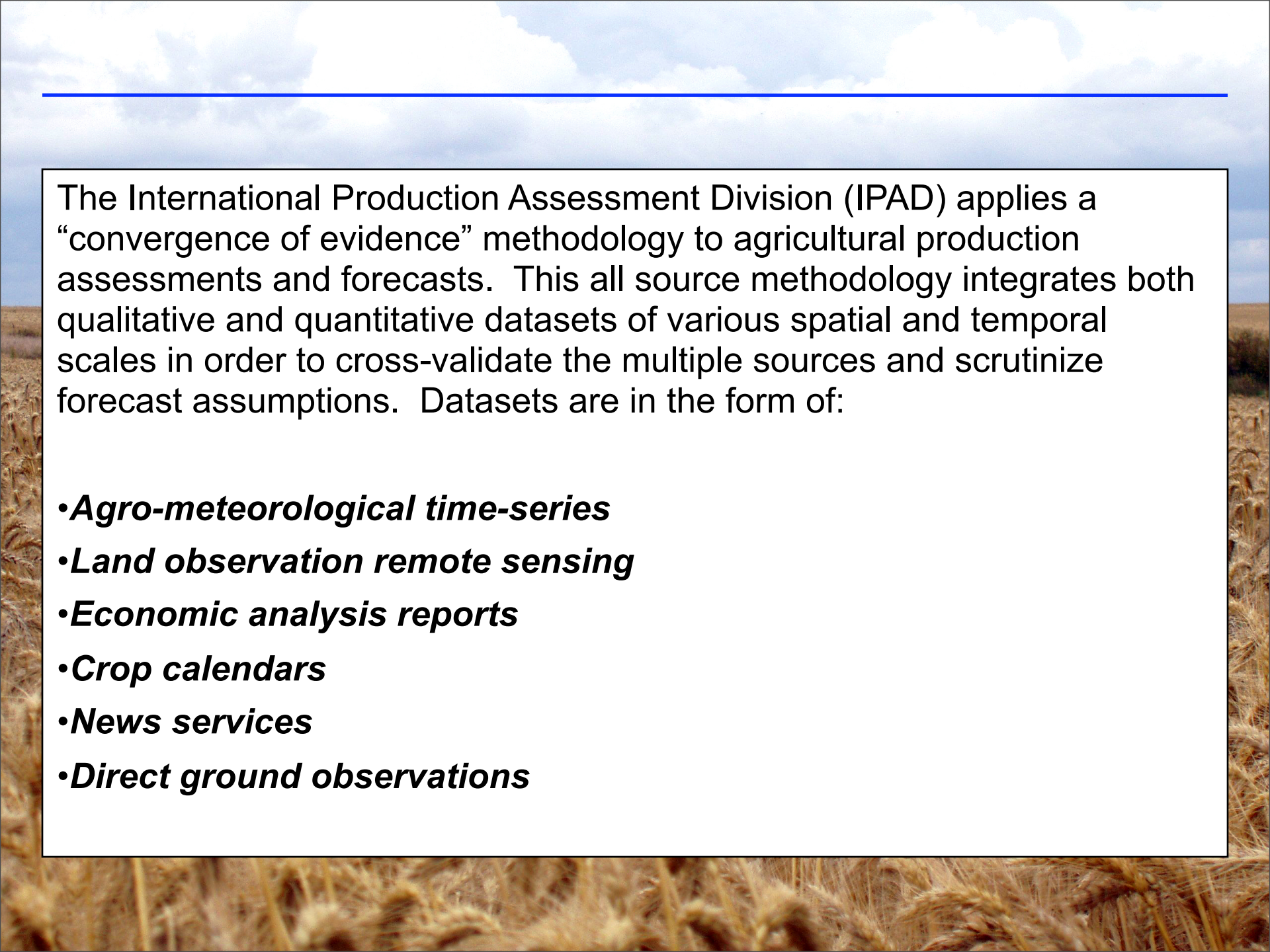
## Abstract:

When developing estimates of crop yield typically a convergence of evidence including weather patterns (rain and heat) ground truthing (actual observations) and remotely sensed data are used. There are numerous areas in the world wherein one or several of the aforementioned areas of evidence are not available.

The presentation will describe the satellite imagery used, detail processes and procedures utilized to fuse the data, explain how the data was analyzed and discuss the results obtained.







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The International Production Assessment Division (IPAD) applies a “convergence of evidence” methodology to agricultural production assessments and forecasts. This all source methodology integrates both qualitative and quantitative datasets of various spatial and temporal scales in order to cross-validate the multiple sources and scrutinize forecast assumptions. Datasets are in the form of:

- ***Agro-meteorological time-series***
- ***Land observation remote sensing***
- ***Economic analysis reports***
- ***Crop calendars***
- ***News services***
- ***Direct ground observations***



# Production, Supply, and Distribution (PSD) Data

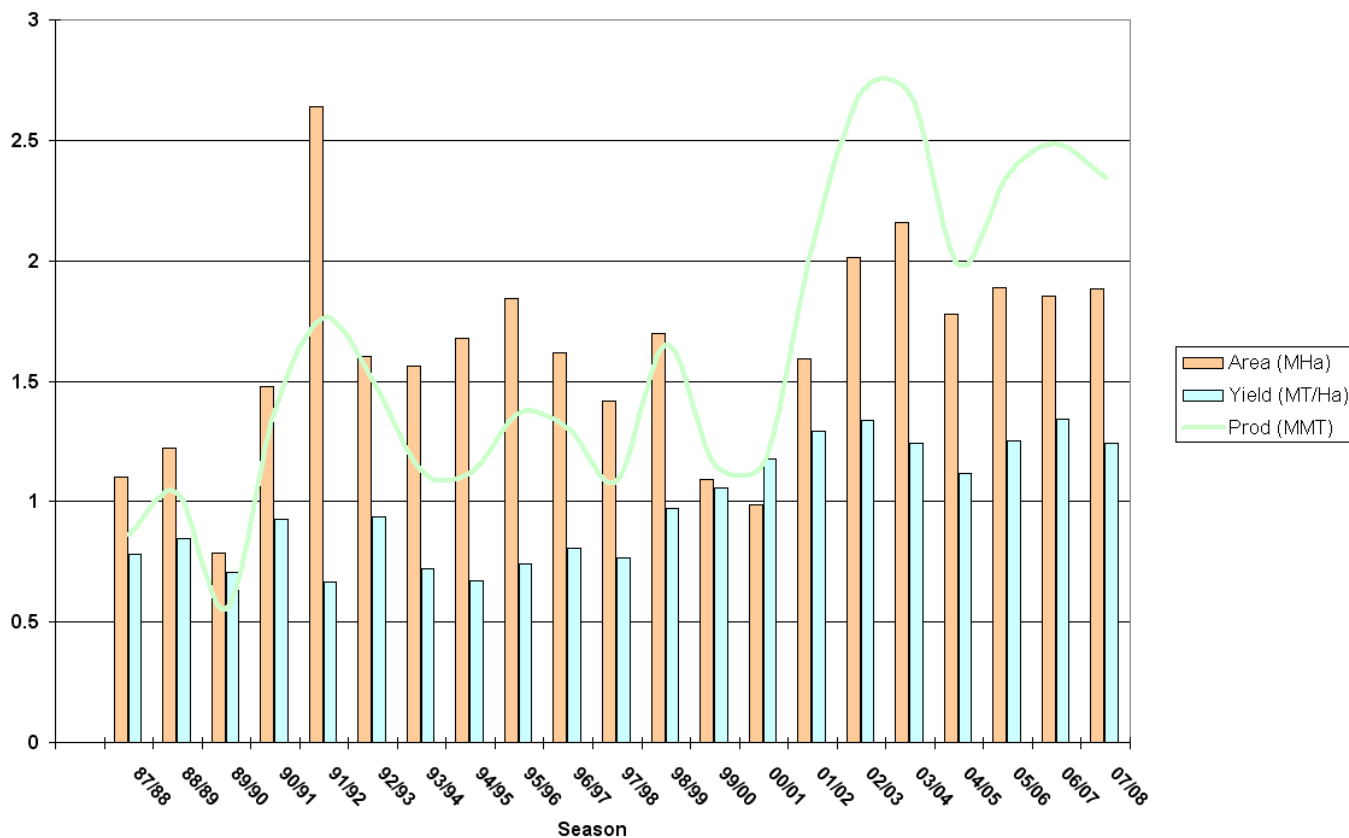
1) Cereal												
Area, Yield and Production of Wheat												
Years	Erbil			Suleimanyah			Dohuk			All three Gov.		
	Cultivated	Yield	Production	Cultivated	Yield	Production	Cultivated	Yield	Production	Cultivated	Yield	Production
	Area/ Ha.	Kg/Ha.	MT	Area/ Ha.	Kg/Ha.	MT	Area/ Ha.	Kg/Ha.	MT	Area / Ha.	Kg/Ha.	MT
1987-1986	128133.8	800.0	102507.0	60056.8	1064.0	15975.1	53360.0	1612.0	21504.1	241550.5	1158.7	139986.2
1988-1987	95245.3	808.0	76958.2	38498.5	1064.0	10240.6	48437.8	1568.0	18987.6	182181.5	1146.7	106186.4
1989-1988	119107.3	380.0	45260.8	34247.5	812.0	6952.2	48186.0	1044.0	12576.5	201540.8	745.3	64789.5
1990-1989	157902.5	880.0	138954.2	73412.8	1260.0	23125.0	64256.3	840.0	13493.8	295571.5	993.3	175573.0
1991-1990	374677.5	560.0	209819.4	326617.0	552.0	45073.1	105064.8	1220.0	32044.7	806359.3	777.3	286937.3
1992-1991	243369.8	600.0	146021.9	148812.5	600.0	22321.9	81367.3	940.0	19121.3	473549.5	713.3	187465.0
1993-1992	189000.0	632.0	119448.0	198835.8	684.0	34000.9	174682.8	1400.0	61139.0	562518.5	905.3	214587.9
1994-1993	184212.0	836.0	154001.2	210126.5	1168.0	61356.9	142325.0	1492.0	53087.2	536663.5	1165.3	268445.4
1995-1994	200776.0	748.0	150180.4	220462.5	1320.0	72752.6	140232.5	1540.0	53989.5	561471.0	1202.7	276922.6
1996-1995	164545.3	600.0	98727.2	164383.0	508.0	20876.6	126847.0	1028.0	32599.7	455775.3	712.0	152203.5
1997-1996	106019.3	780.0	82695.0	141377.0	852.0	30113.3	115952.5	968.0	28060.5	363348.8	866.7	140868.8
1998-1997	110593.5	1076.0	118998.6	132931.8	996.0	33100.0	83893.5	1244.0	26090.9	327418.8	1105.3	178189.5
1999-1998	95217.8	396.0	37706.2	102546.0	468.0	11997.9	77862.5	348.0	6774.0	275626.3	404.0	56478.1
2000-1999	79757.3	968.0	77205.0	130611.8	740.0	24163.2	79757.3	968.0	19301.3	290126.3	892.0	120669.4
2001-2000	90548.8	1176.0	106485.3	129475.5	1084.0	35087.9	84978.0	1604.0	34076.2	305002.3	1288.0	175649.4
2002-2001	132842.8	1364.0	181197.5	163325.0	1136.0	46384.3	121519.3	1588.0	48243.1	417687.0	1362.7	275825.0
2003-2002	235015.0	1200.0	282018.0	109190.0	1400.0	38216.5	128937.5	1044.0	33652.7	473142.5	1214.7	353887.2
2004-2003	98962.5	944.0	93420.6	70111.8	1428.0	25029.9	98310.0	1300.0	31950.8	267384.3	1224.0	150401.2
2005-2004	116777.5	624.0	72869.2	153115.0	976.0	37360.1	102277.0	752.0	19228.1	372169.5	784.0	129457.3
2006-2005	126888.0	1056.0	133993.7	120409.5	1088.0	32751.4	90814.5	1396.0	31694.3	338112.0	1180.0	198439.4



# Production, Supply, and Distribution (PSD) Data


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Area, Yield and Production of Wheat												
Years	Erbil			Suleimanyah			Dohuk			All three Gov.		
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	Area/ Ha.	Kg/Ha.	MT	Area/ Ha.	Kg/Ha.	MT	Area/ Ha.	Kg/Ha.	MT	Area / Ha.	Kg/Ha.	MT
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2006-2005	126888.0	1056.0	133993.7									

PSD National Data (IRAQ)





# Production, Supply, and Distribution (PSD) Online

 United States Department of Agriculture  
Foreign Agricultural Service

psd  
Production, Supply and Distribution Online

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## Production, Supply and Distribution Online

Welcome to the Foreign Agricultural Service's Production, Supply and Distribution (PSD) online database. This database contains current and historical official USDA data on production, supply and distribution of agricultural commodities for the United States and key producing and consuming countries.

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### Release Schedule

Get the complete PSD data release schedule for the current calendar year. PSD data will next be released on: **Friday, December 07, 2007**

---

### Perform a Custom Query

View PSD Official Statistics onscreen or create downloadable files for your spreadsheet or database program.

---

### Downloadable Data Sets

Downloadable files containing Official Statistics are generated when each commodity's data is released. These data files include all attributes, countries and years pertaining to a particular commodity.

---

### Reports (Listed by Category)

Click on a Category to expand the list and reveal available Reports. Click on the desired Report in the list to view it.

- + Coffee
- + Cotton
- + Dairy
- + Field Crops
- + Fruits and Vegetables
- + Grains and Pulses
- + Juice

### My PSD Online

Signing in to PSD Online allows you to save your Custom Queries.

[New User](#)  
[Forgot Your Password?](#)

Username:   
Password:

**Note:** It is not necessary to sign in to view PSD data.

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### More PSD Information


- o **Data Availability**  
Get a list of available data and country market year information ...
- o **Data Publications**  
Current World Production, Market and Trade Reports, and other data publications ...
- o **Regions**  
Countries as they are grouped in PSD's regions ...


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### See Also ...

- o **IDB Summary**

# Production, Supply, and Distribution (PSD) Online

 United States Department of Agriculture  
Foreign Agricultural Service

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Production, Supply and Distribution Online

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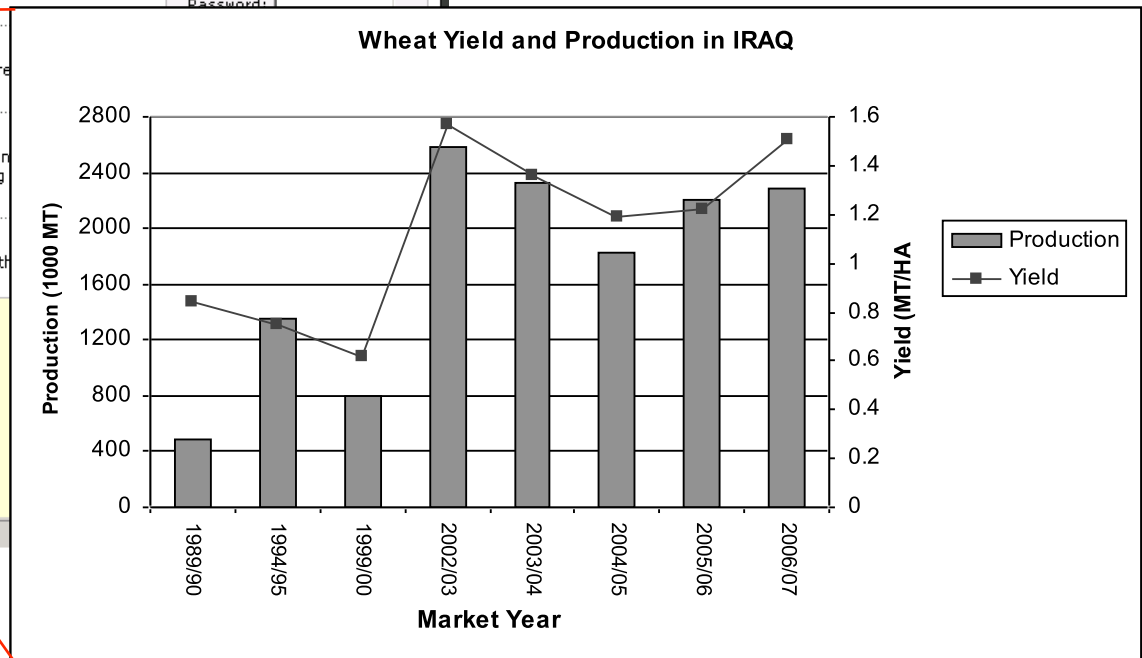
### My PSD Online

Signing in to PSD Online allows you to save your Custom Queries.

[New User](#)  
[Forgot Your Password?](#)

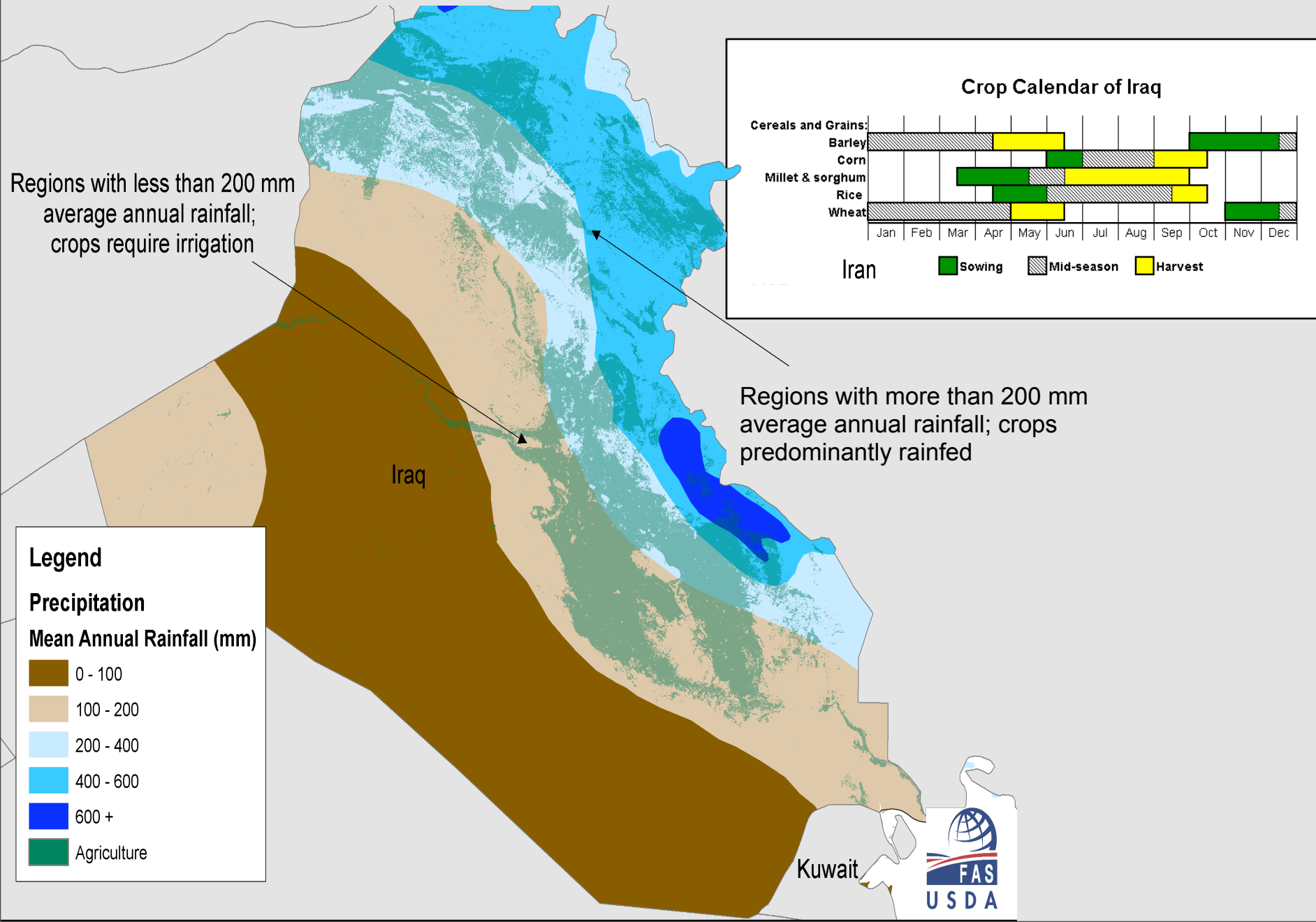
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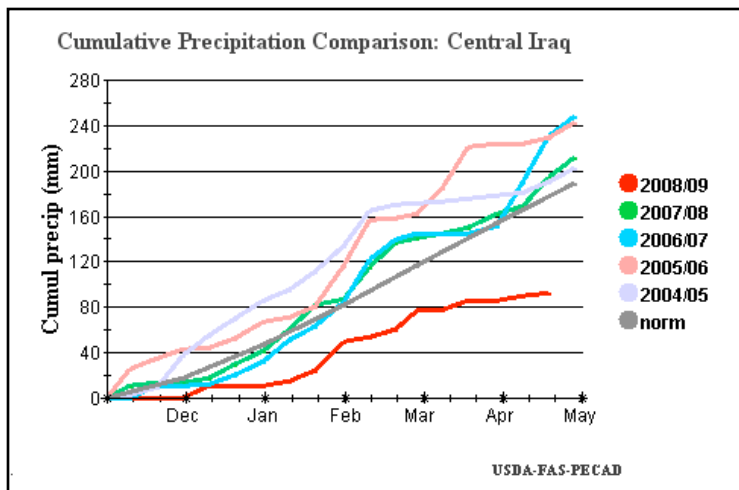
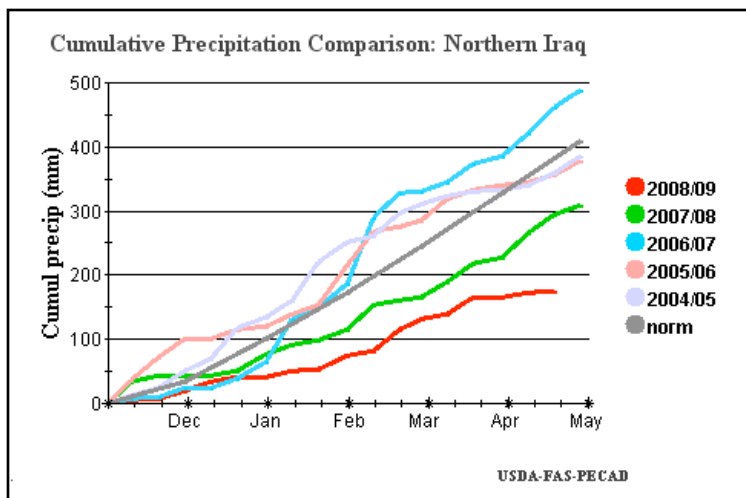


# Agro-climatic Data (Precipitation)

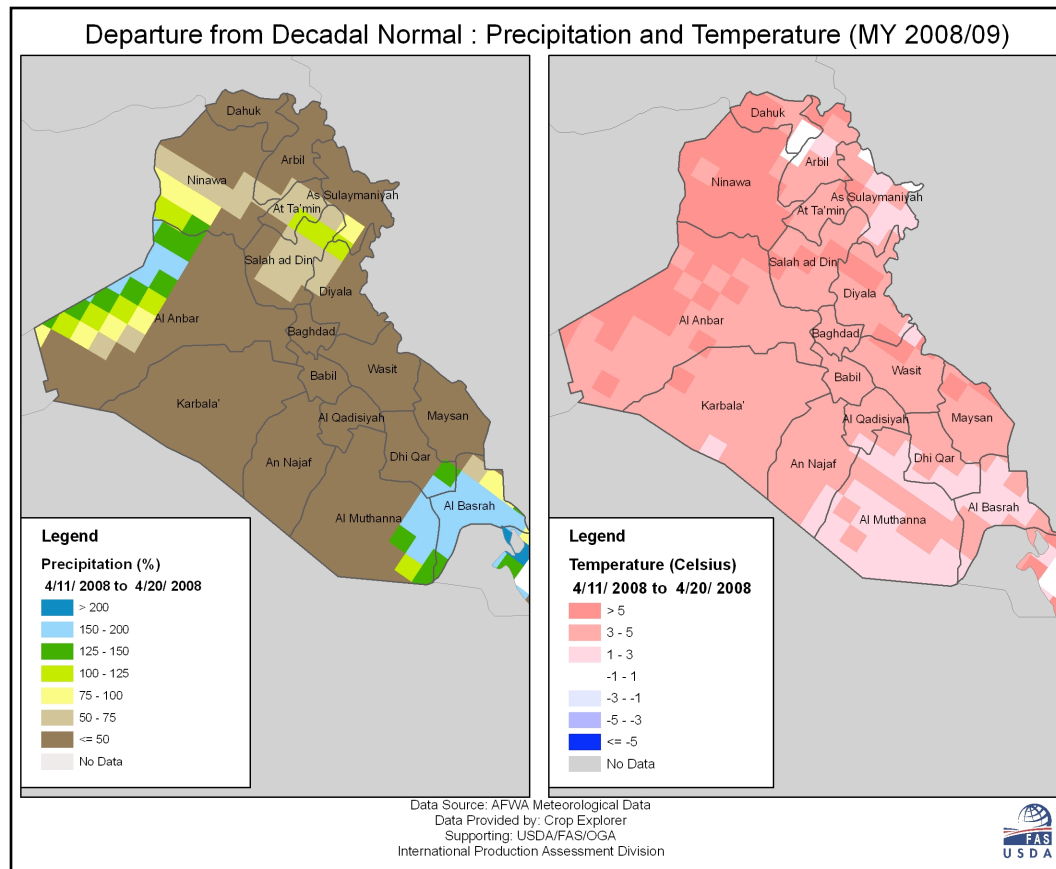


# Agro-climatic Data (Precipitation & Temperature)

## CADRE XPlot



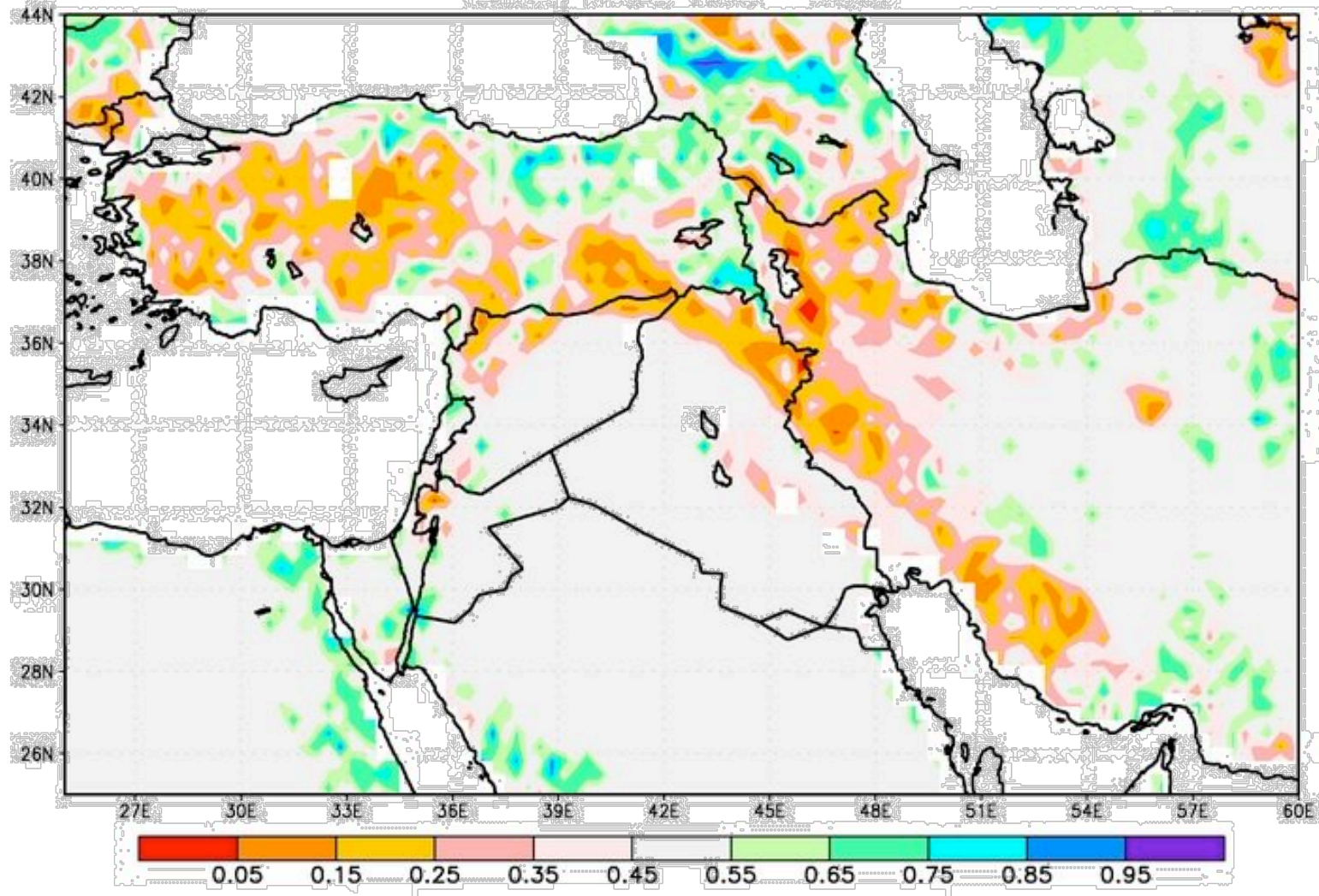
## Crop Explorer (GIS Interface)





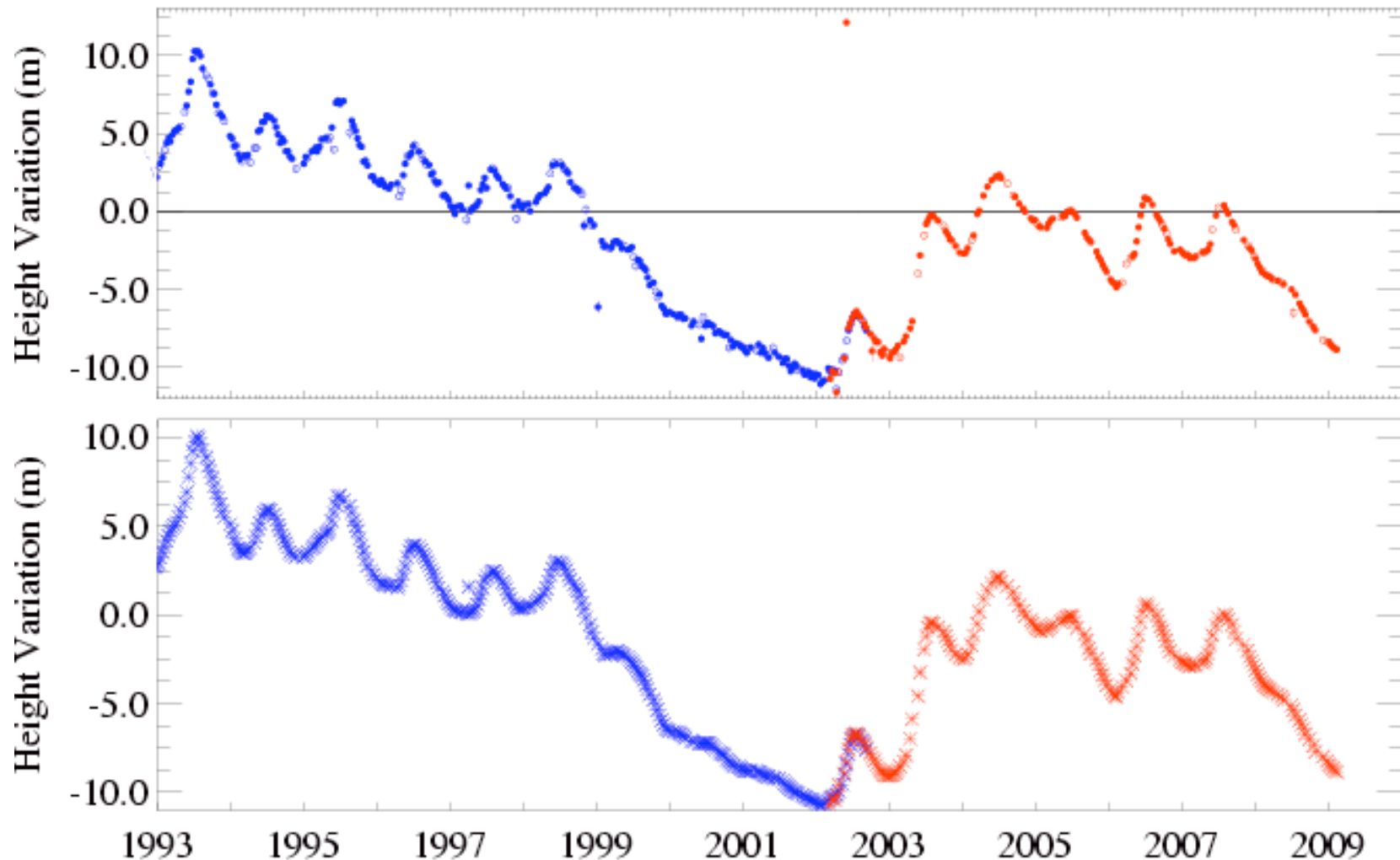
# Agro-climatic Data (SSM/I Surface Wetness)

SATELLITE DERIVED SURFACE WETNESS ANOMALIES — MIDDLE EAST  
STANDARDIZED ANOMALIES FOR APRIL 14 — 20, 2008  
BASE PERIOD 1988 — 2008



# Hydrological Data (Reservoir Monitor )

Lake Tharthar Height Variations  
TOPEX 10 Year Geo-referenced 10Hz Along Track Reference



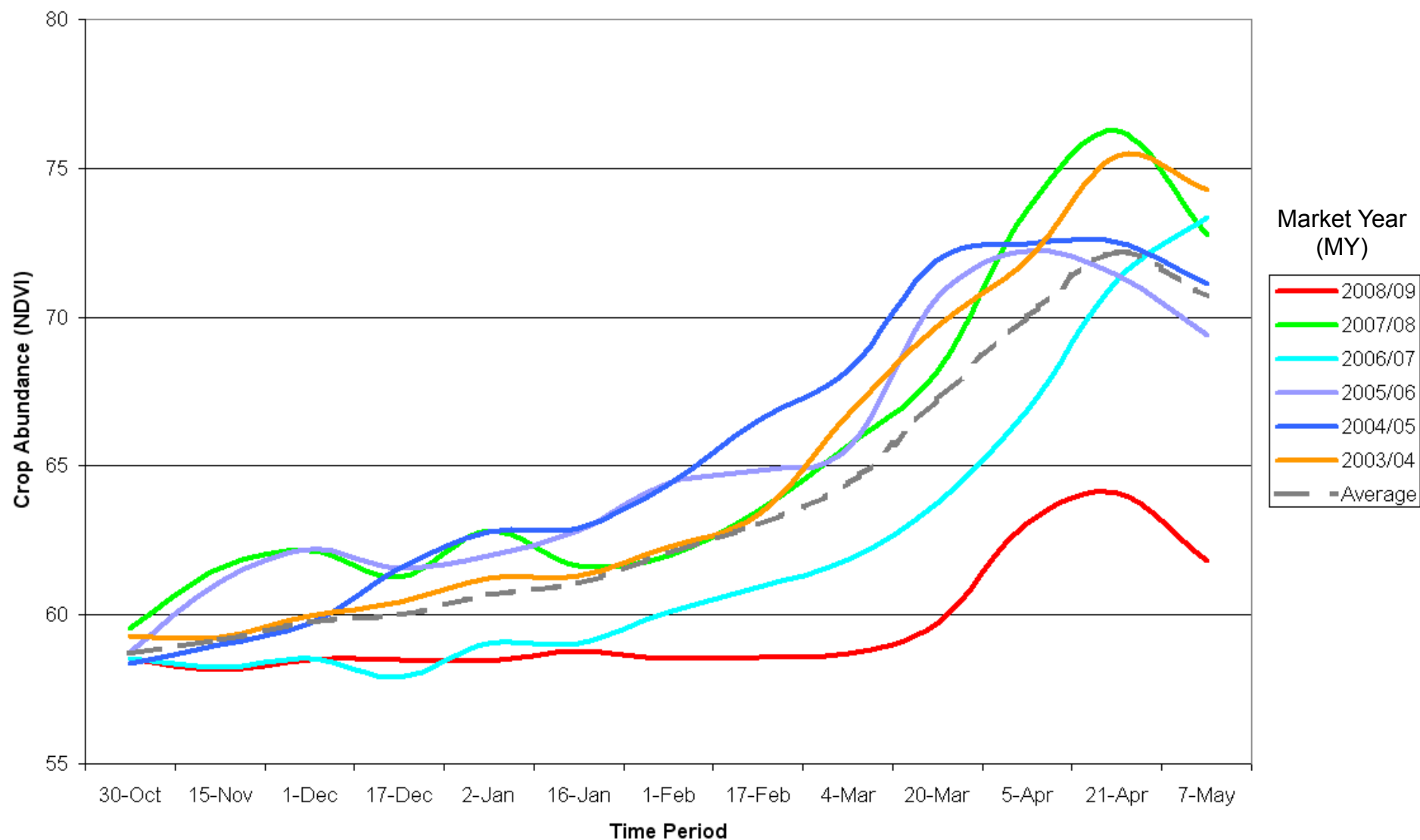
\*\*\* TOPEX/Poseidon historical archive  
\*\*\* Jason-1 Interim GDR 20hz altimetry

Version TPJ.2  
Last valid elevation : 11 Jan., 2009



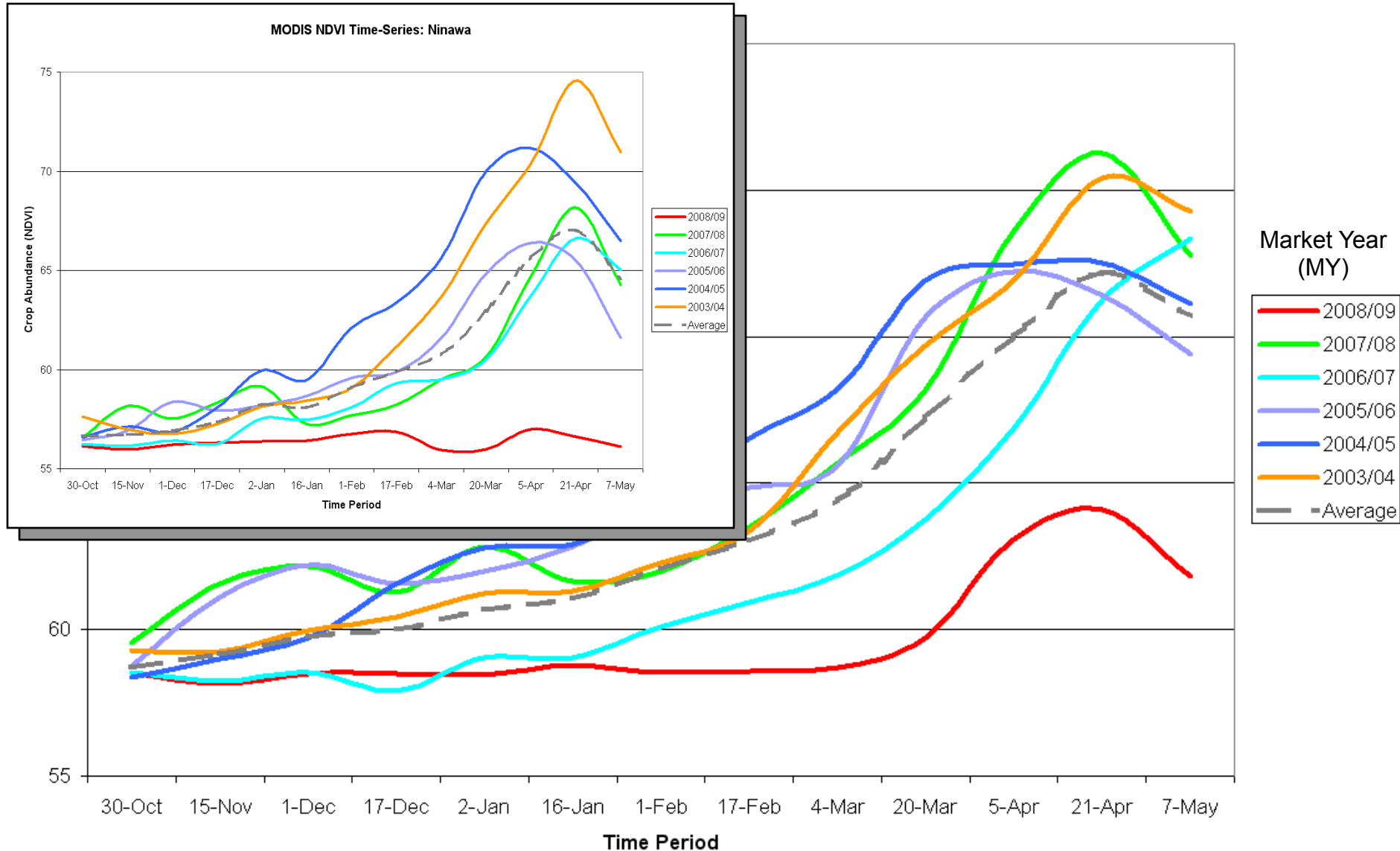
# Agro-climatic Data MODIS Normalized Difference Vegetation Index (NDVI)

MODIS NDVI Time Series: Northern Iraq



# Agro-climatic Data MODIS Normalized Difference Vegetation Index (NDVI)

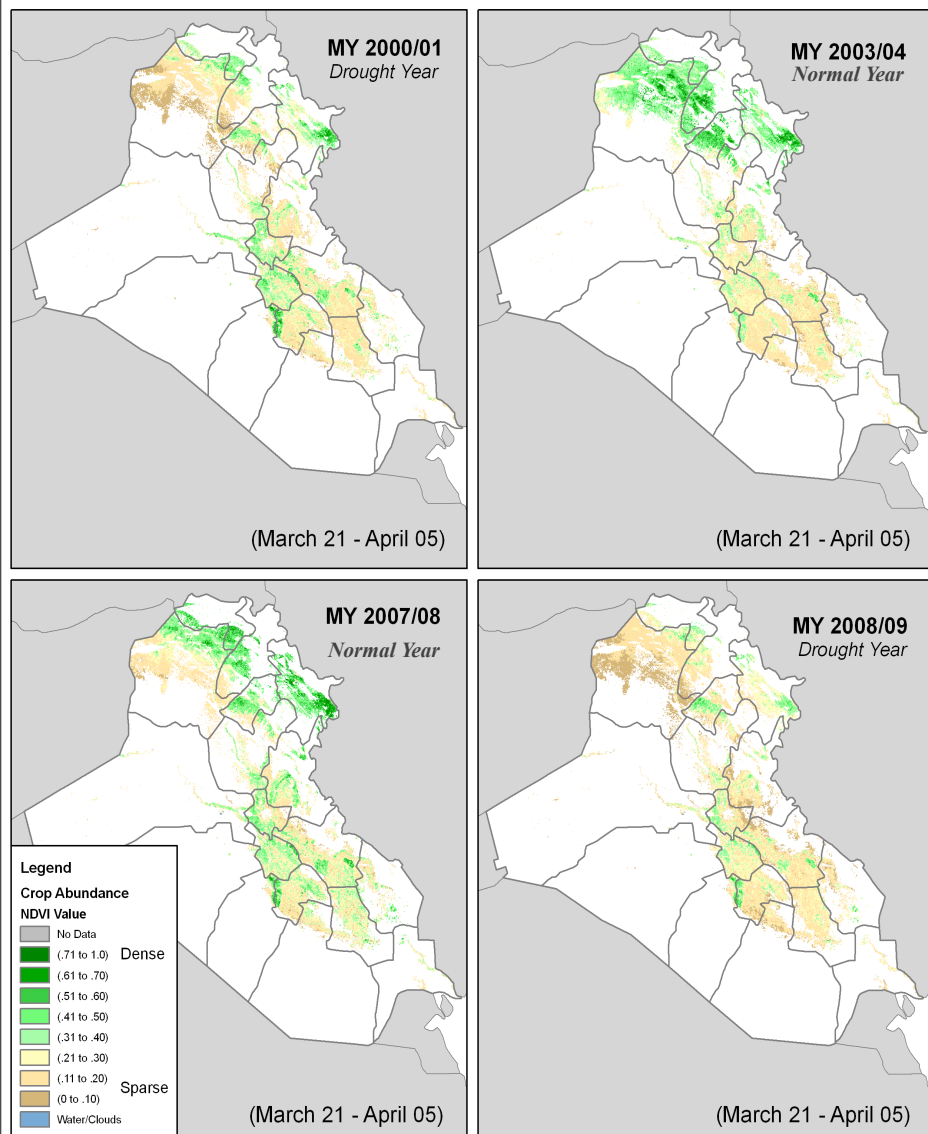
## MODIS NDVI Time Series: Northern Iraq





# Agro-climatic Data (MODIS NDVI Time Series)

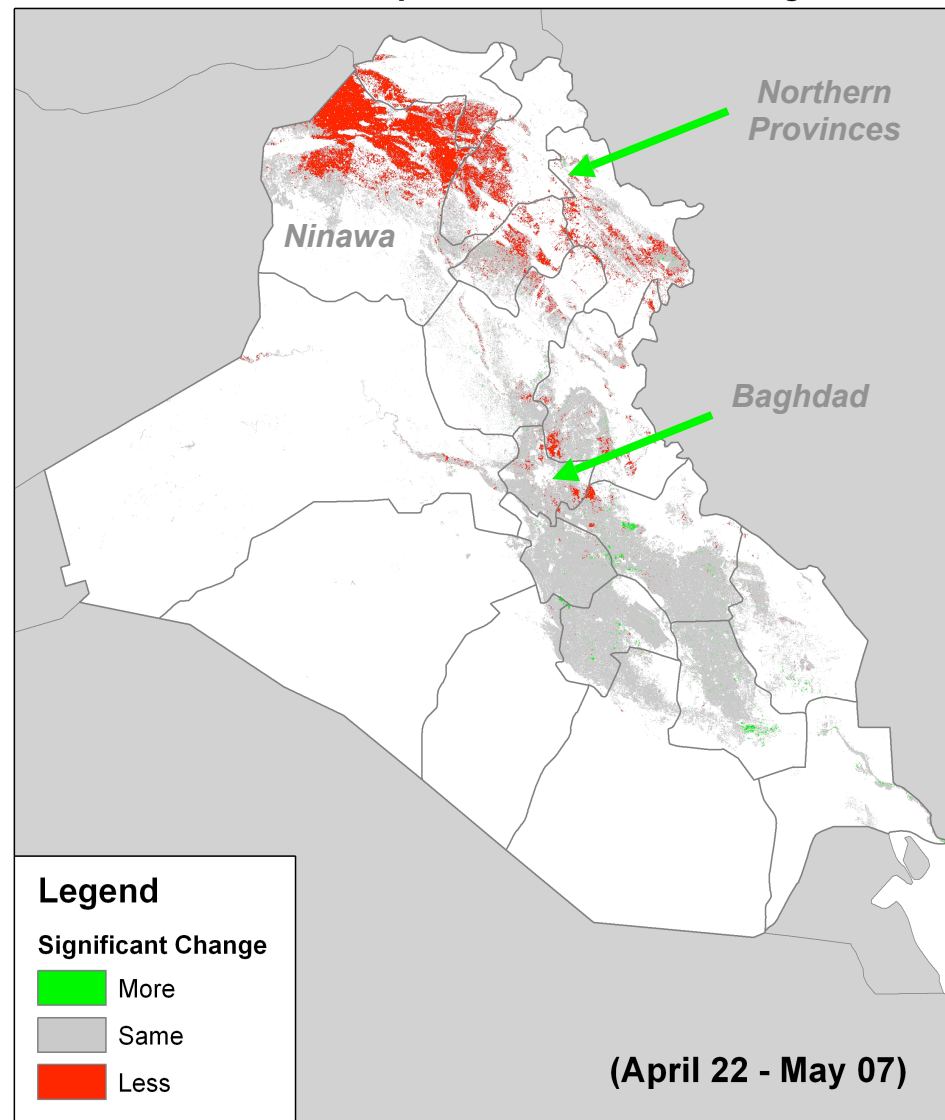
Crop Abundance Image Comparison: MY 2000/01 to MY 2008/09



Data Source: MODIS 250-meter NDVI  
Data Provided by: University of Maryland  
Supporting: USDA/FAS/OGA  
International Production Assessment Division



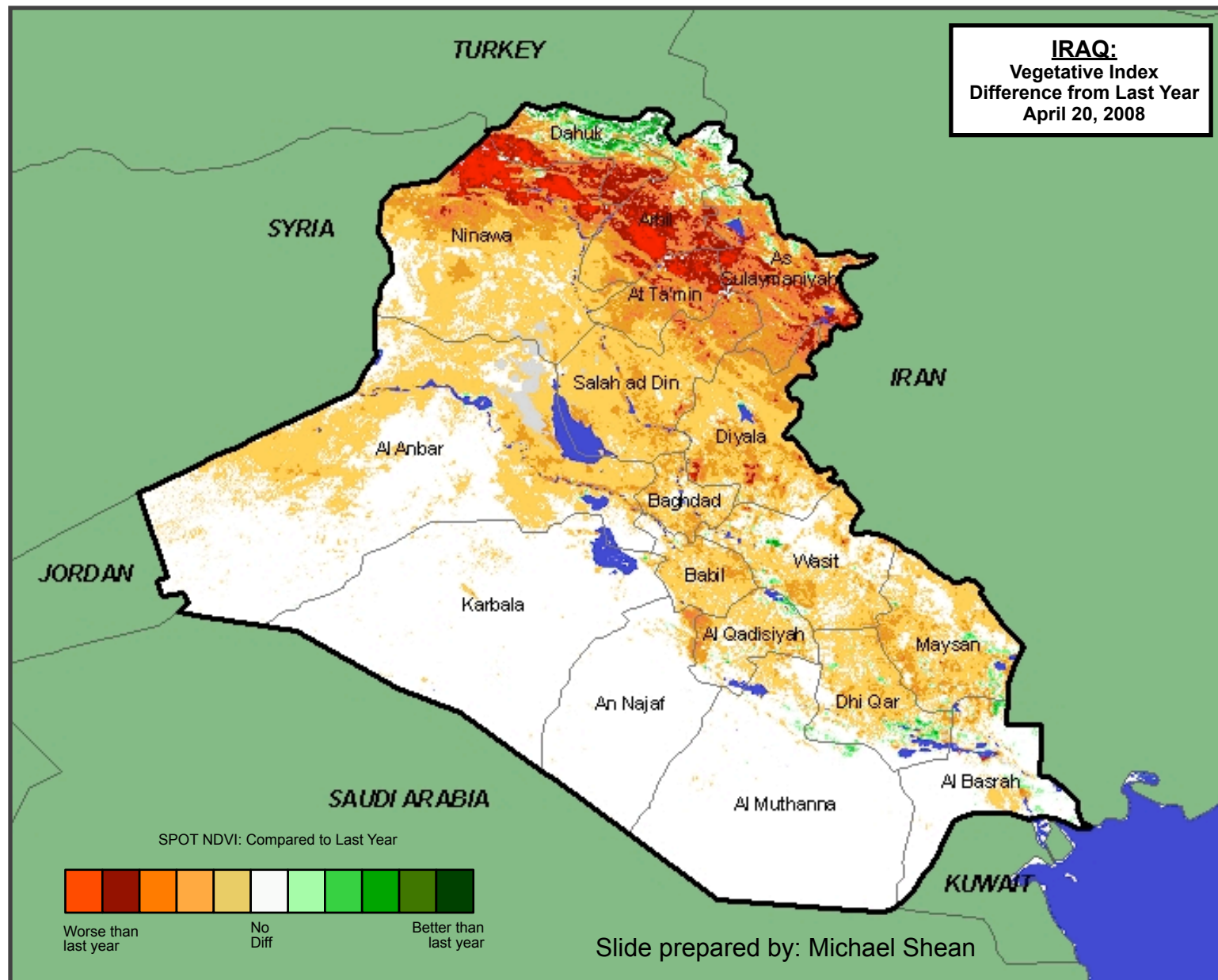
MODIS NDVI: Departure from 9-Year Average



Data Source: MODIS 250-meter NDVI  
Data Provided by: University of Maryland  
Supporting: USDA/FAS/OGA  
International Production Assessment Division



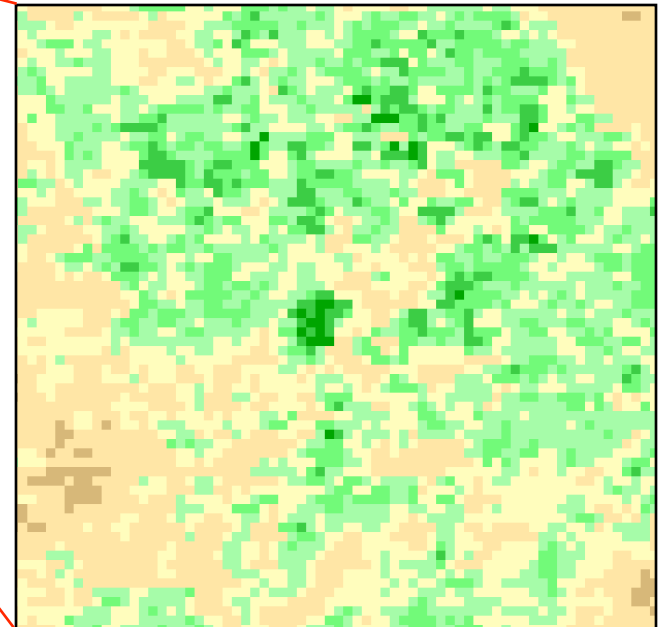
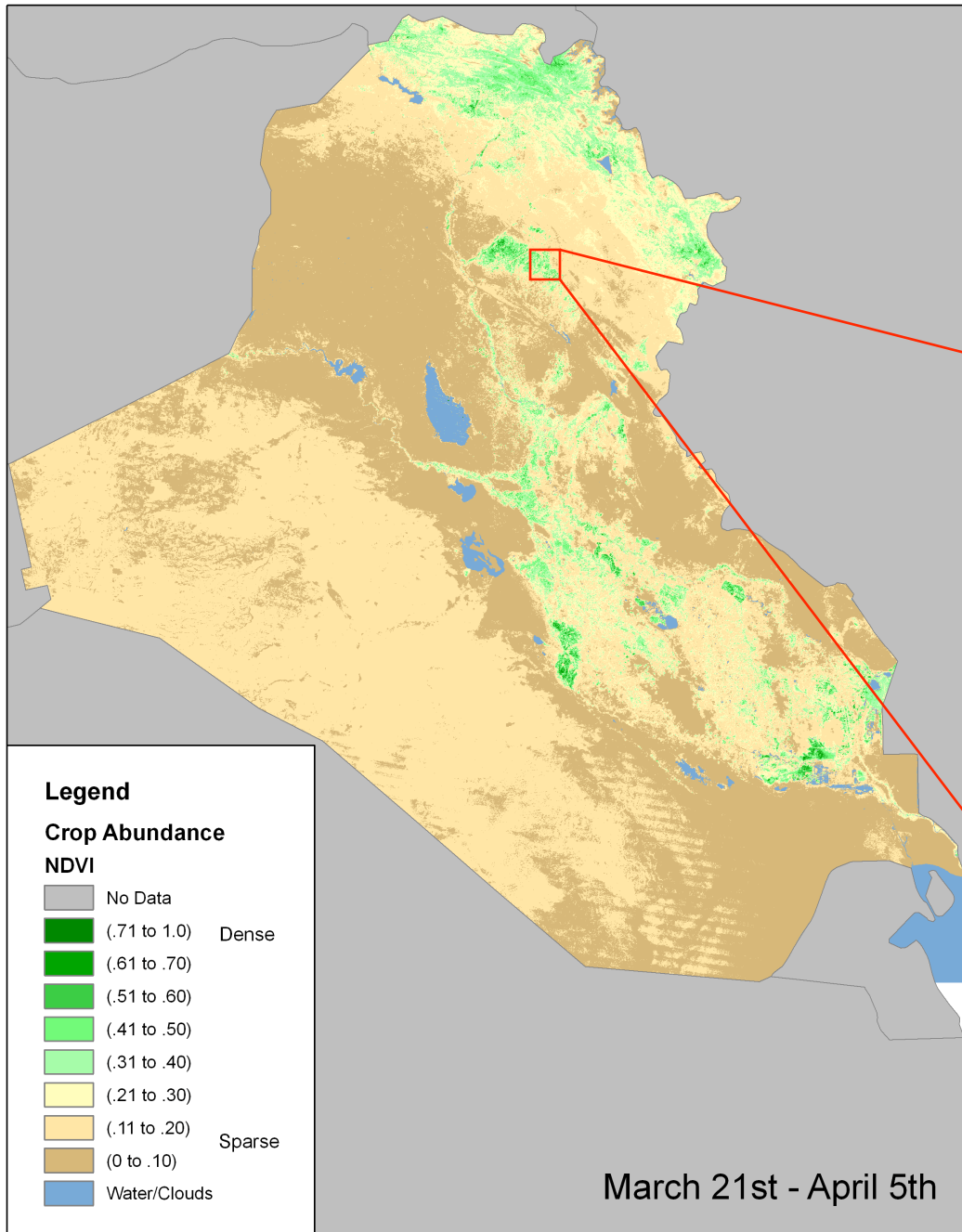
# Agro-climatic Data (SPOT VEG Time Series)



## MODIS 250-meter:

1. Large Scale Regional Analysis
2. Time series analysis
3. Coarse spatial resolution

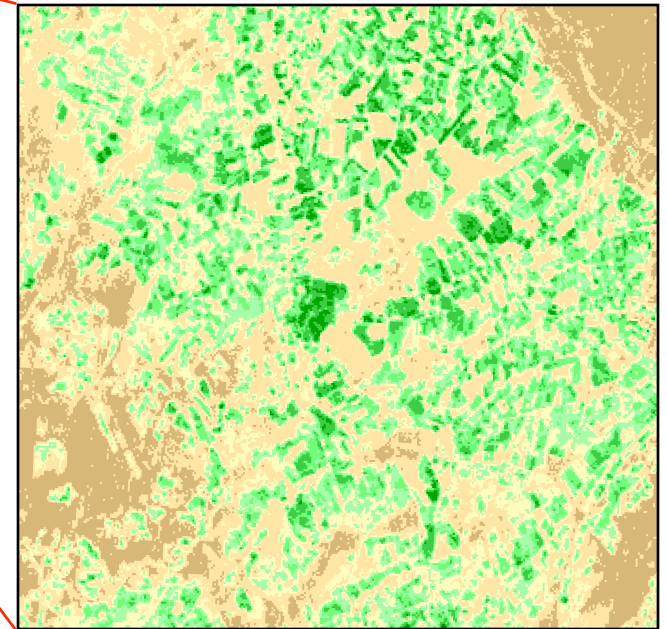
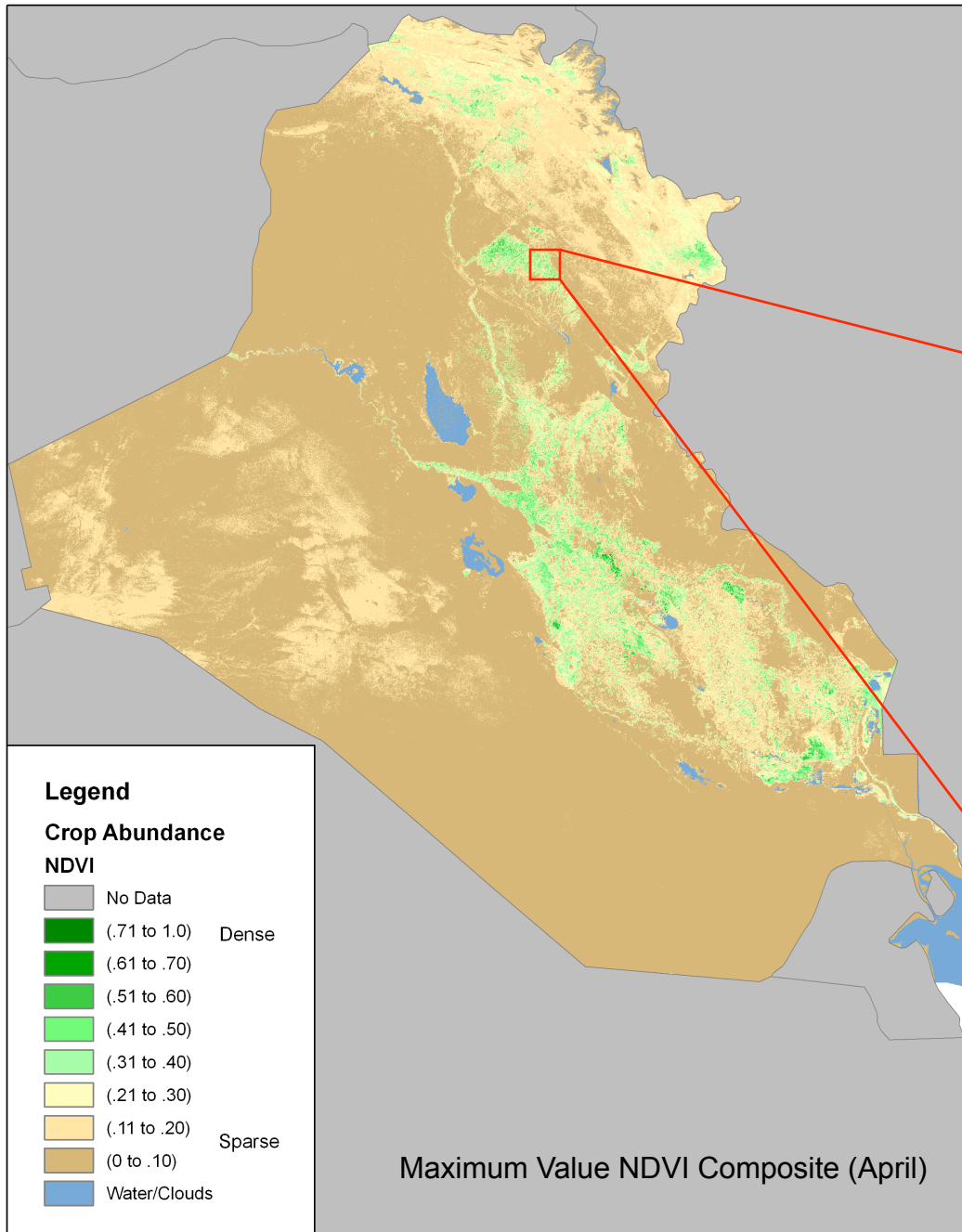
(You Can Not Discern Individual Fields)





## AWiFS 56-meter:

1. Large Scale Regional Analysis
2. Moderate spatial resolution
3. Lacking time series data  
(2008 - First Year of Collection)

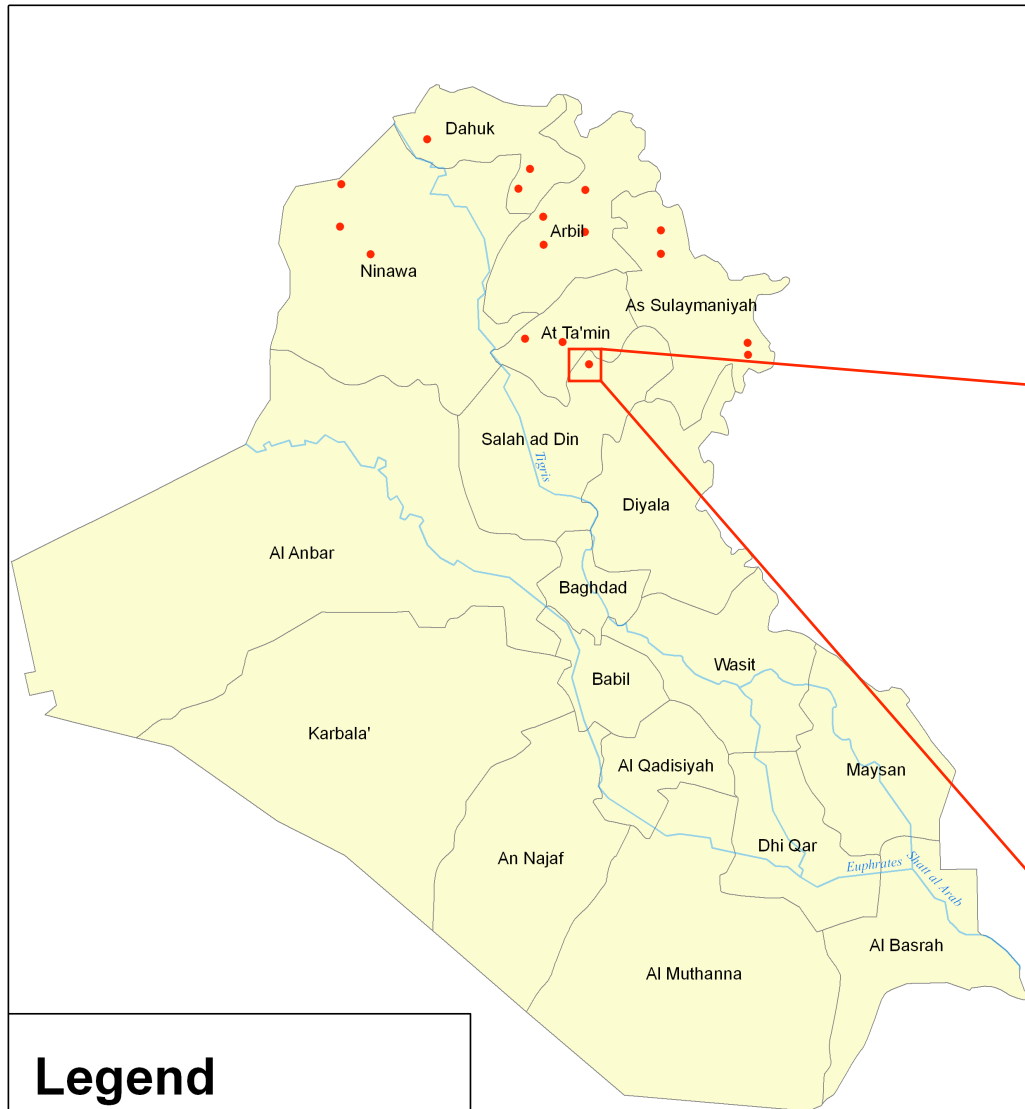




# Image-based Ground Truthing

## Digital Globe Quickbird

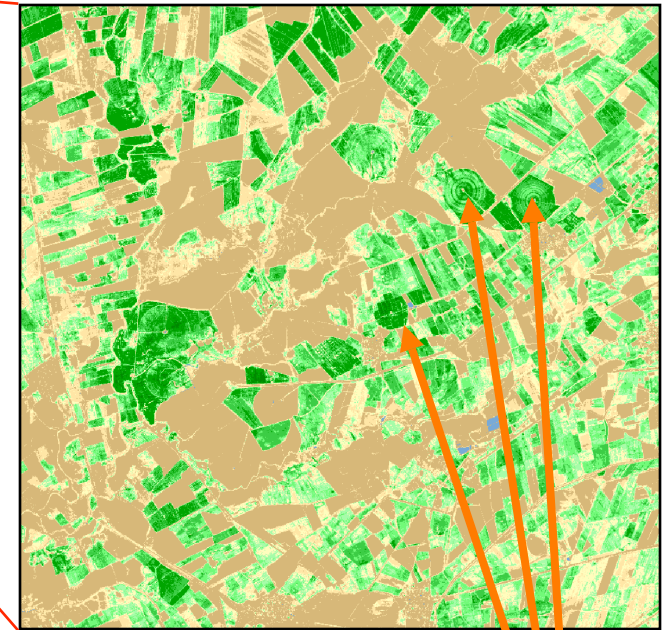
1. Support through NGA
2. Acquired over Northern Provinces
3. ~ 2.44 meter multispectral  
(Limited Coverage – 13km Swath)



## Legend

• Quickbird AOI's

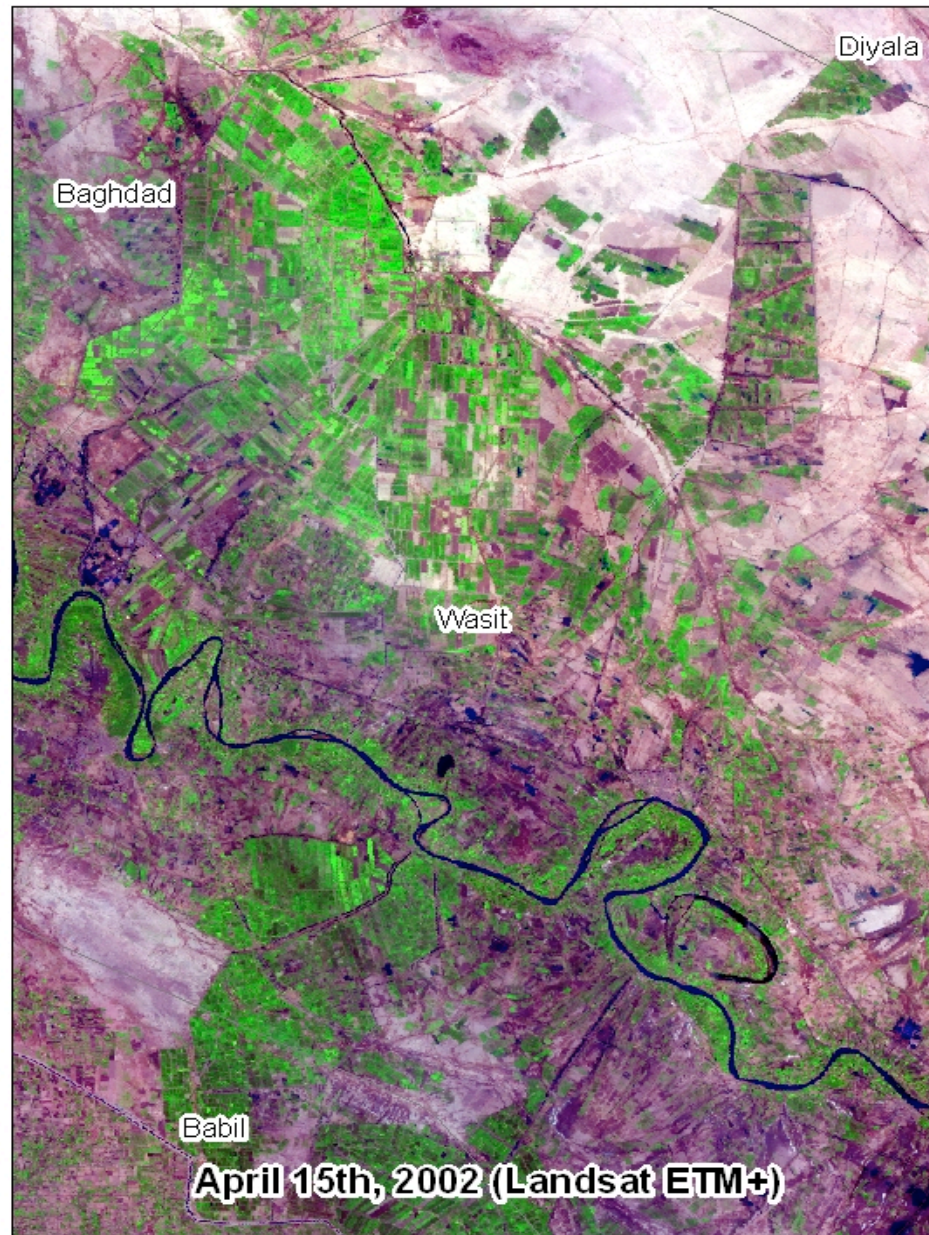
■ Governorate



*Center  
Pivot  
Irrigation*

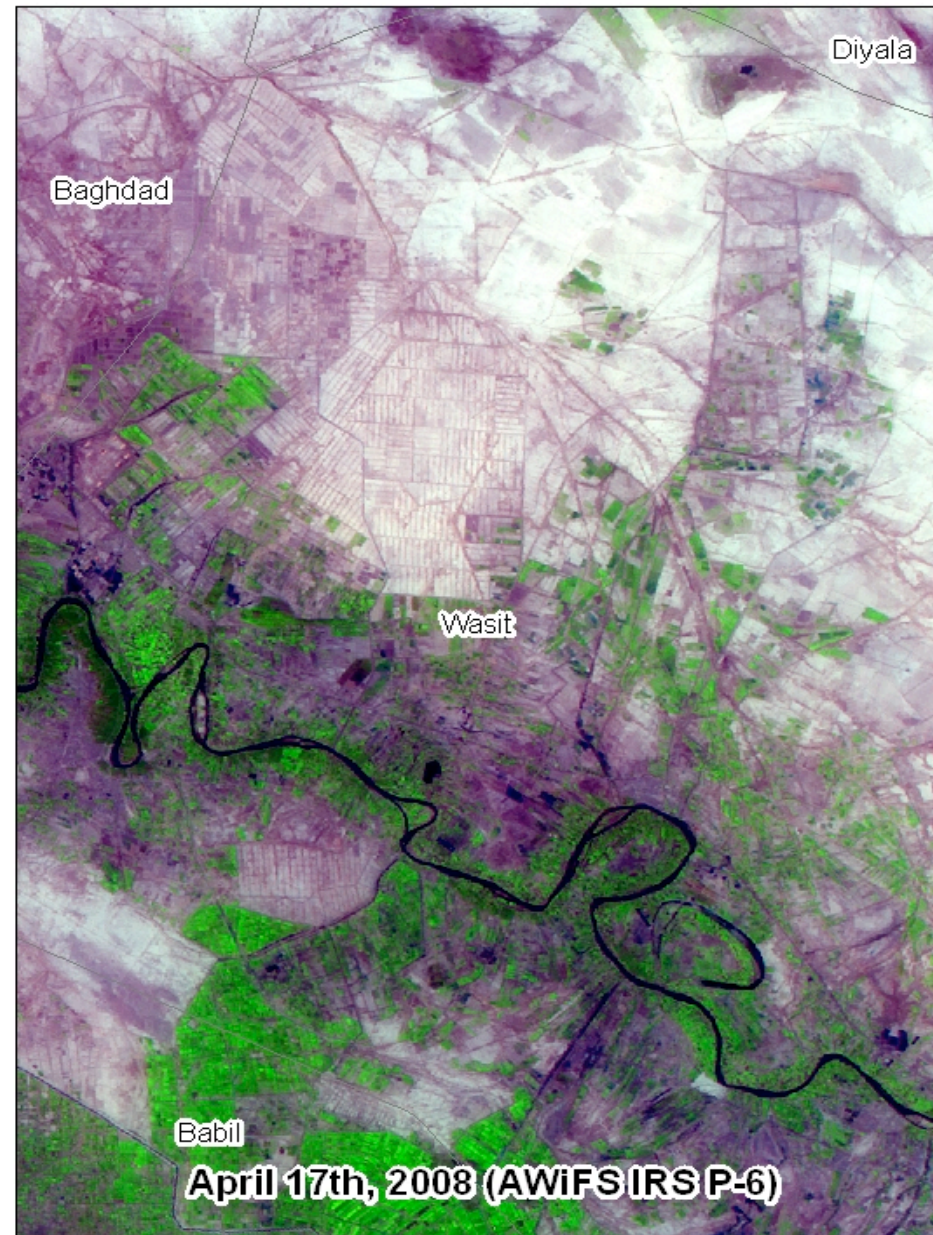


# Multi-temporal Change Detection: Comparison of Current and Archived Data



**Spectral Bands 3,4 and 5**

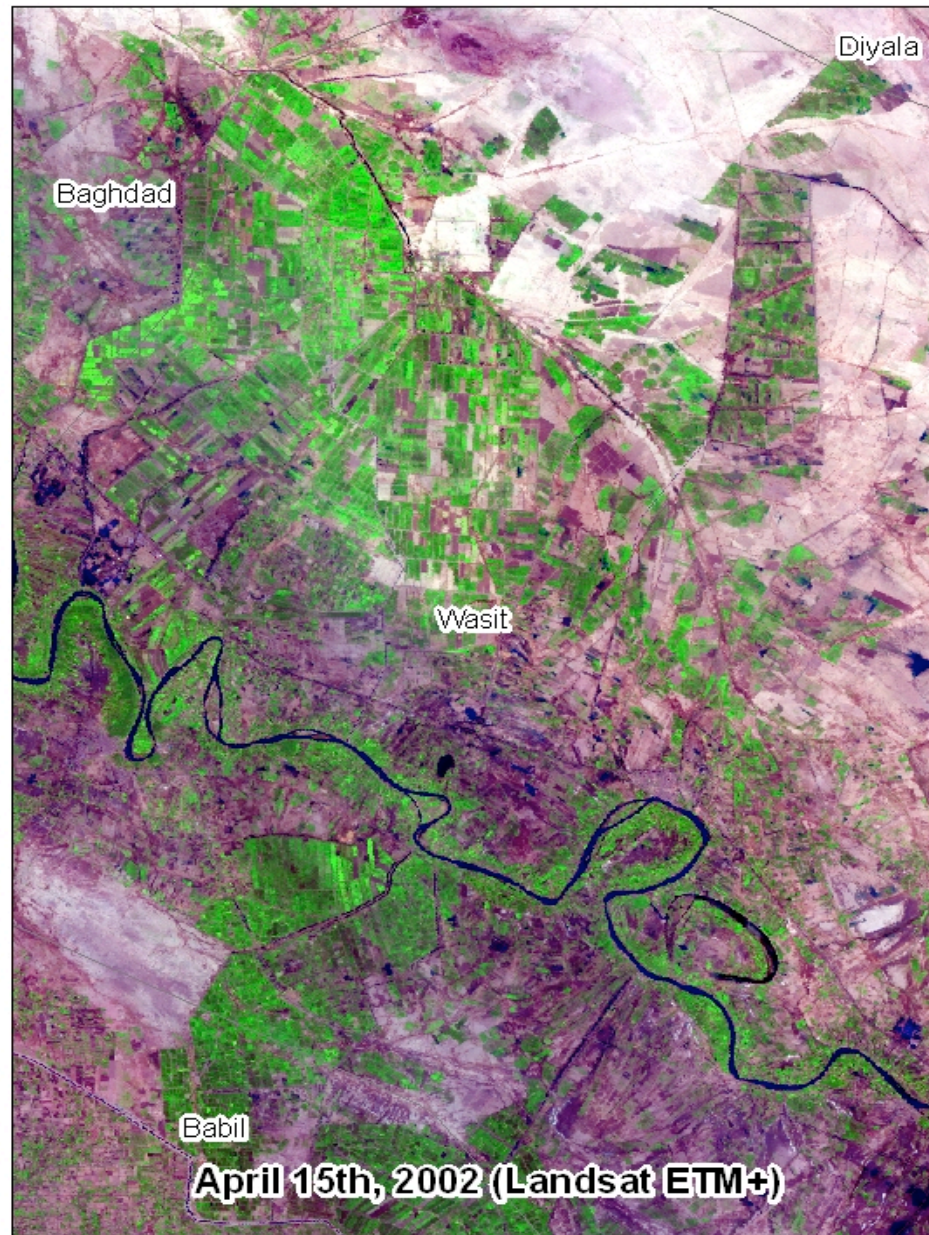
Data Source: Landsat ETM+/AWIFS IRS P-6  
Data Provided by: Archive Explorer/NGA  
Supporting: USDA/FAS/OGA  
International Production Assessment Division



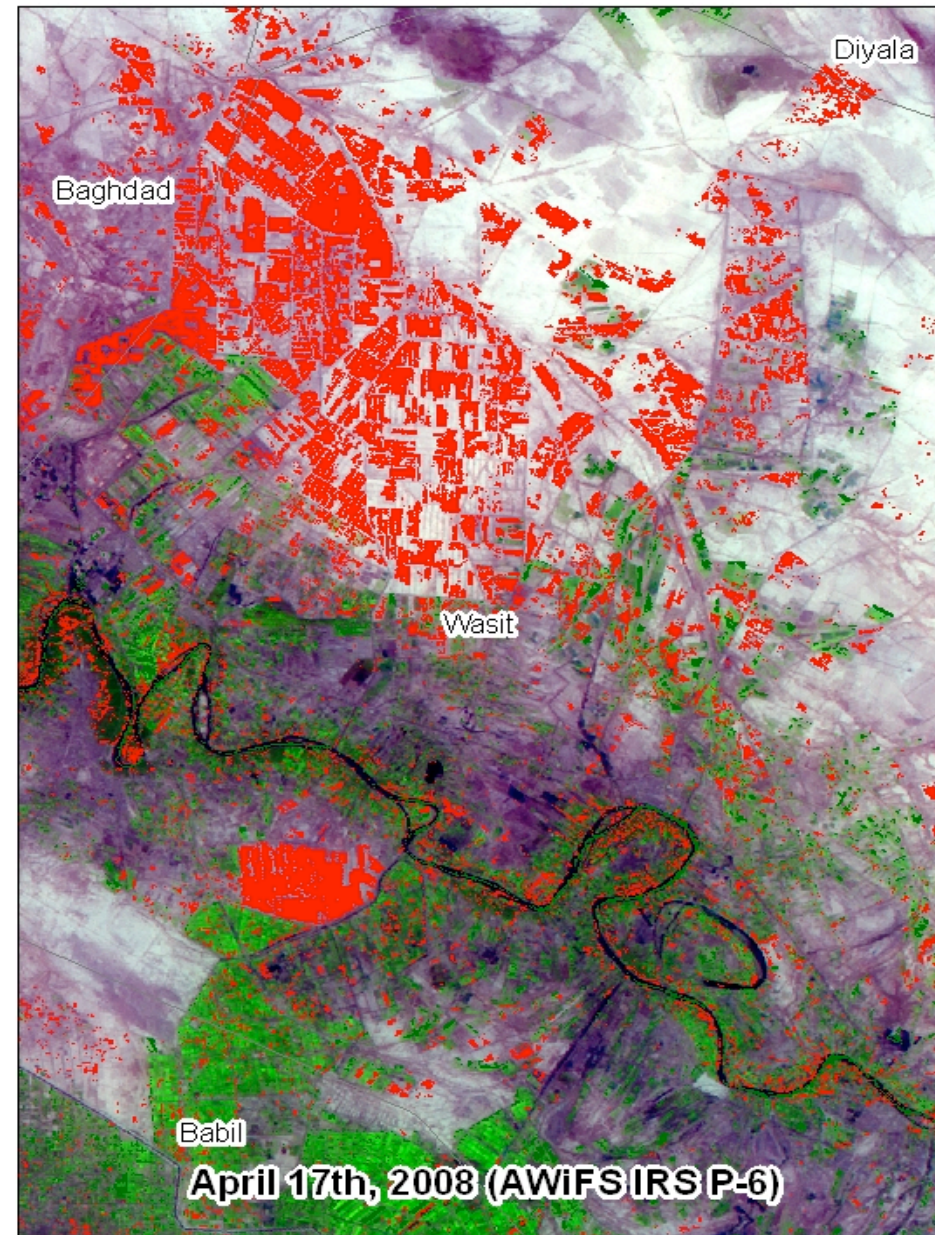
**Spectral Bands 2, 3 and 4**



# Multi-temporal Change Detection: Comparison of Current and Archived Data



**Spectral Bands 3,4 and 5**



**Spectral Bands 2, 3 and 4**

Data Source: Landsat ETM+/AWIFS IRS P-6  
Data Provided by: Archive Explorer/NGA  
Supporting: USDA/FAS/OGA  
International Production Assessment Division



# Winter Grains Harvest Map: MY 2008/09

Early May

Wasit

Maysan

## Legend

- More
- Harvest
- Same

Early April

Wasit

Al Qadisiyah

Maysan

Wasit

Babil

Wasit

Babil

Data Source: AWiFS IRS P-6

Data Provided by: National Geospatial Intelligence Agency

Supporting: USDA/FAS/OGA

International Production Assessment Division



# Winter Grains Harvest Map: MY 2008/09

Early May

Wasit

Maysan

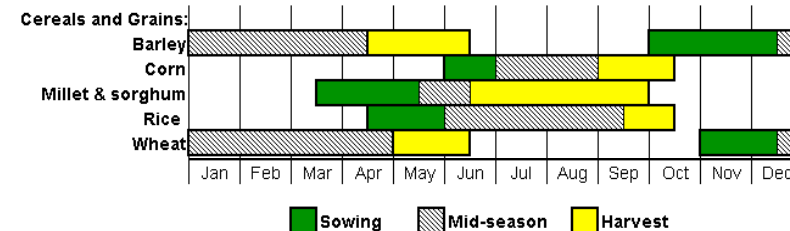
## Legend

- More
- Harvest
- Same

Early April

Wasit

## Crop Calendar of Iraq



Wasit

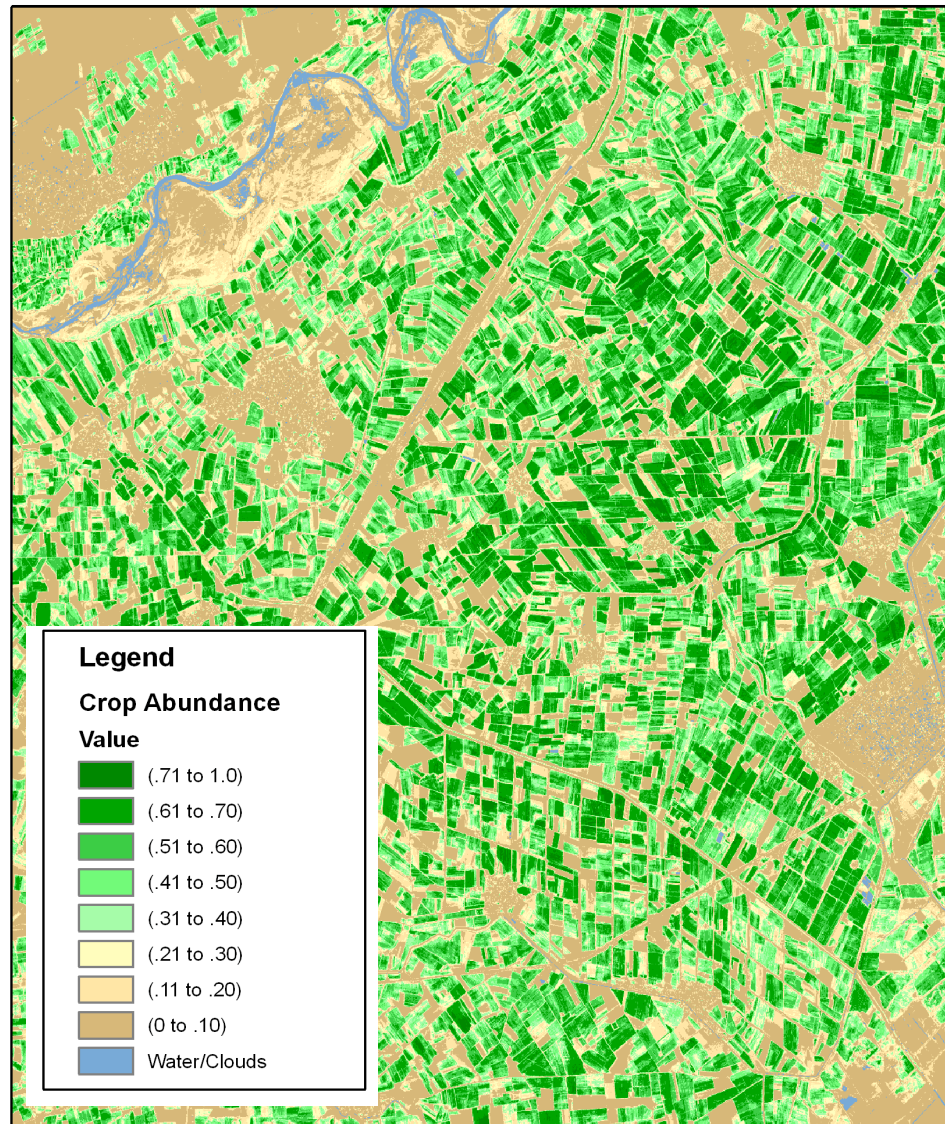
Babil

Wasit

Babil



# NDVI comparison: Quickbird & AWiFS IRS P-6



Quickbird

Mar 29, 2008



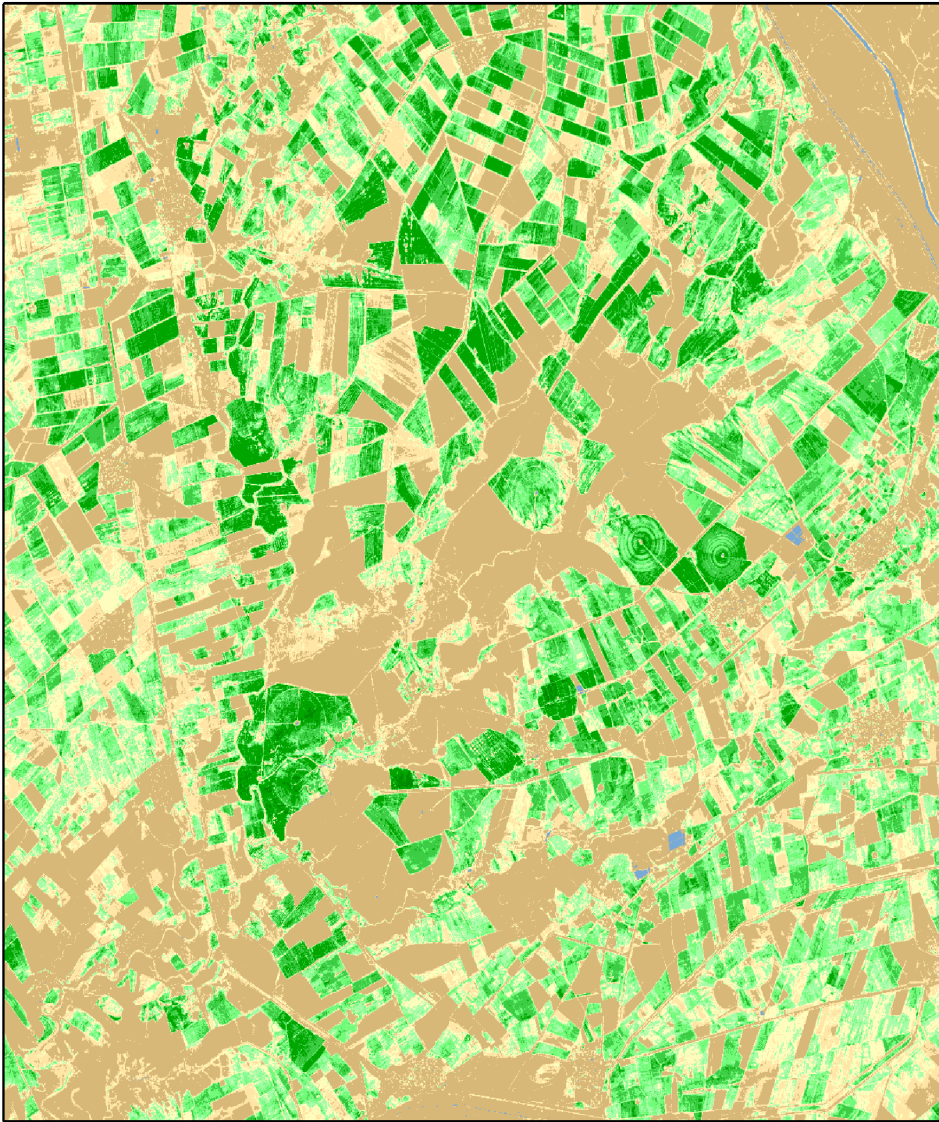
AWiFS IRS P-6

April 3, 2008



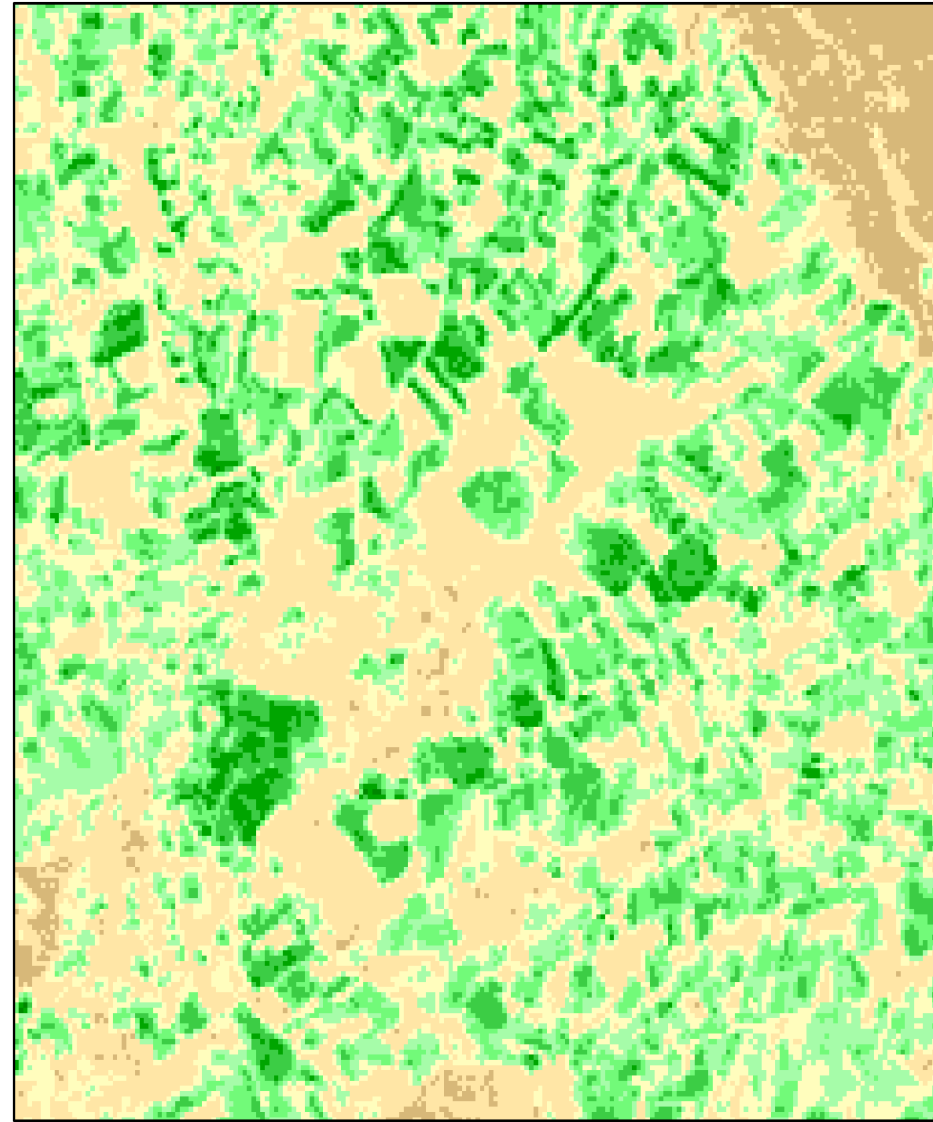
# NDVI comparison: Quickbird & AWiFS IRS P-6

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Quickbird

April 1, 2008

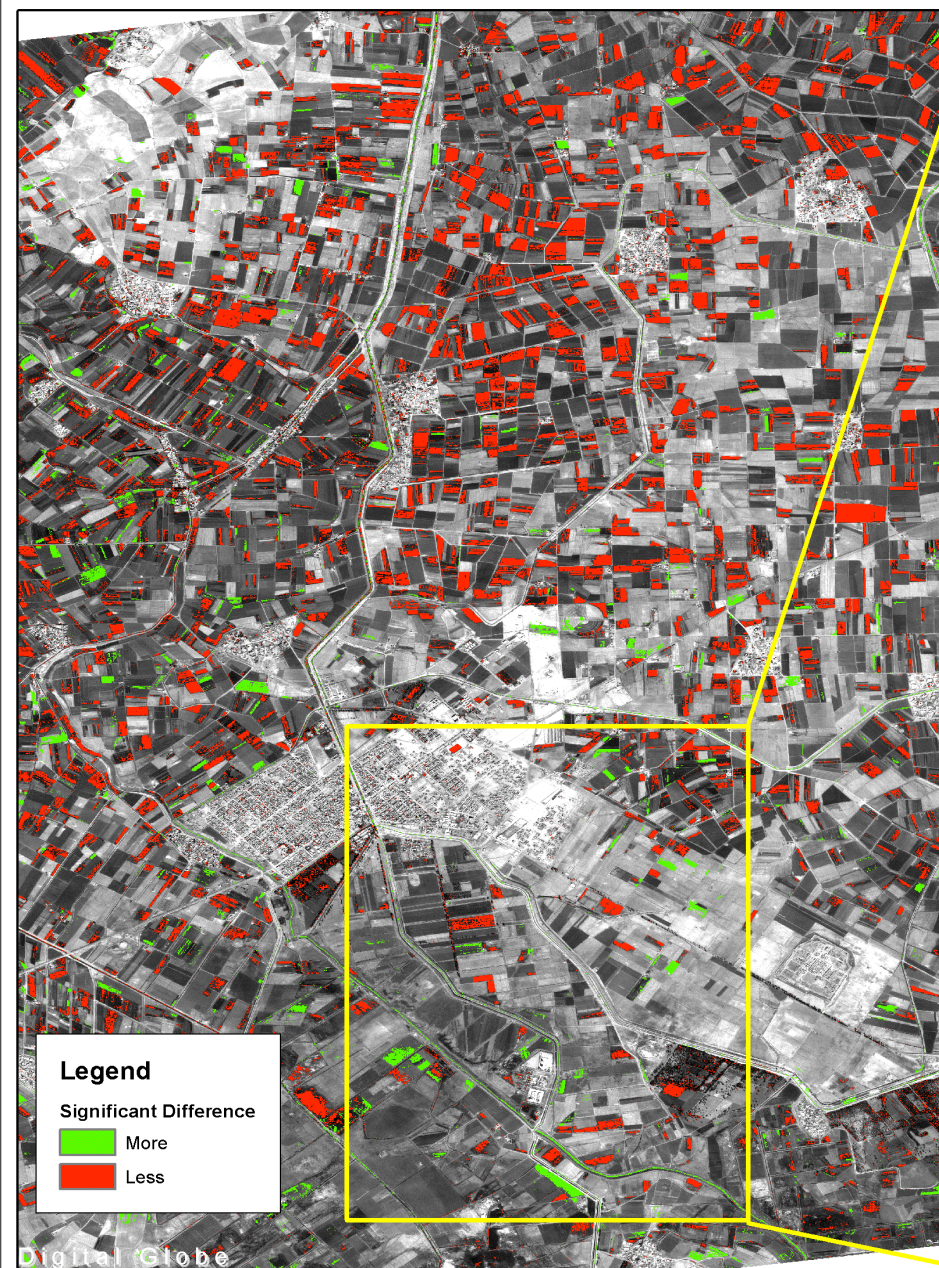


AWiFS IRS P-6

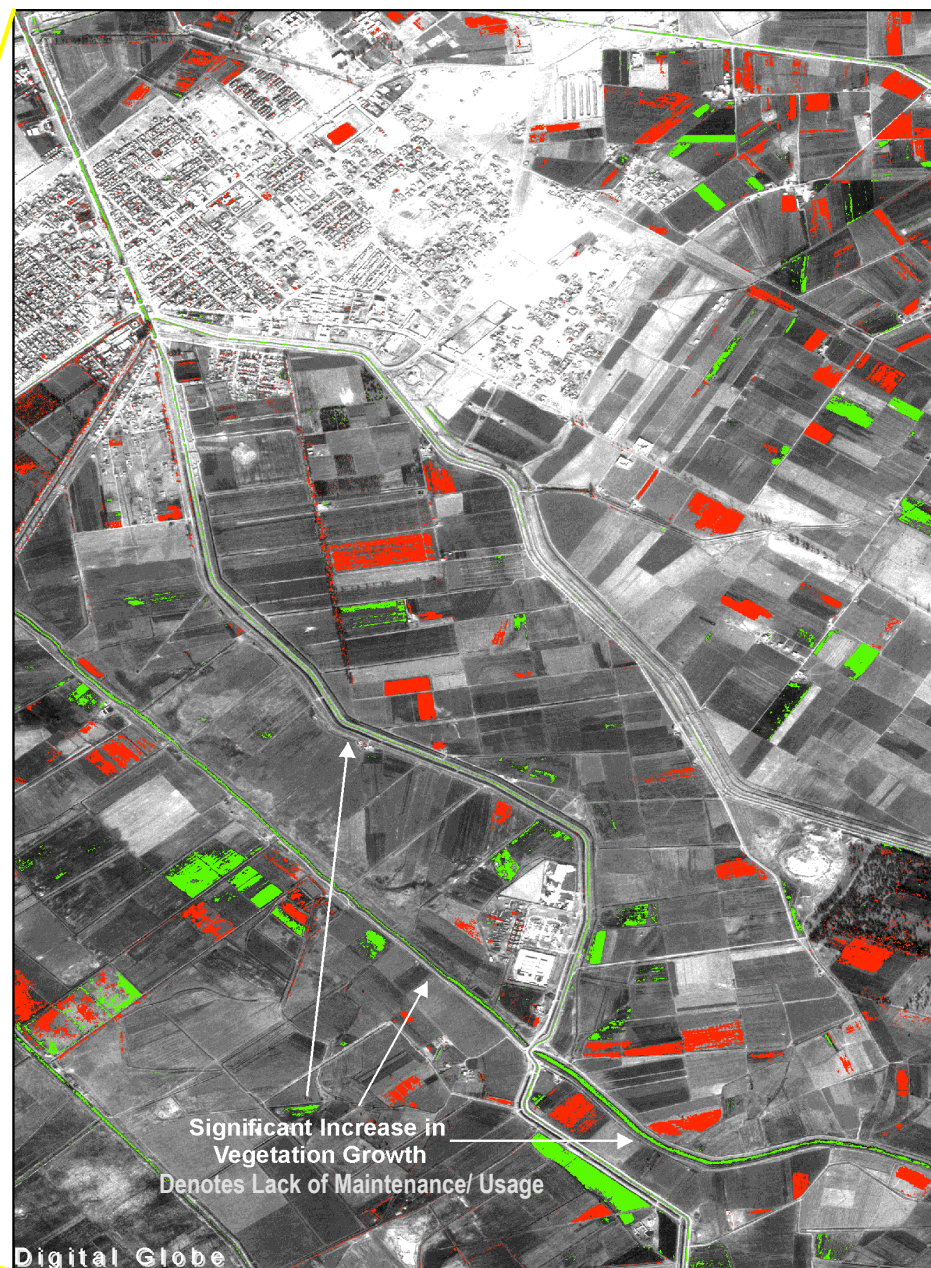
April 3, 2008



# Multi-Temporal Change Analysis between October 26th, 2005 and December 14th, 2007



December 14th, 2007



December 14th, 2007

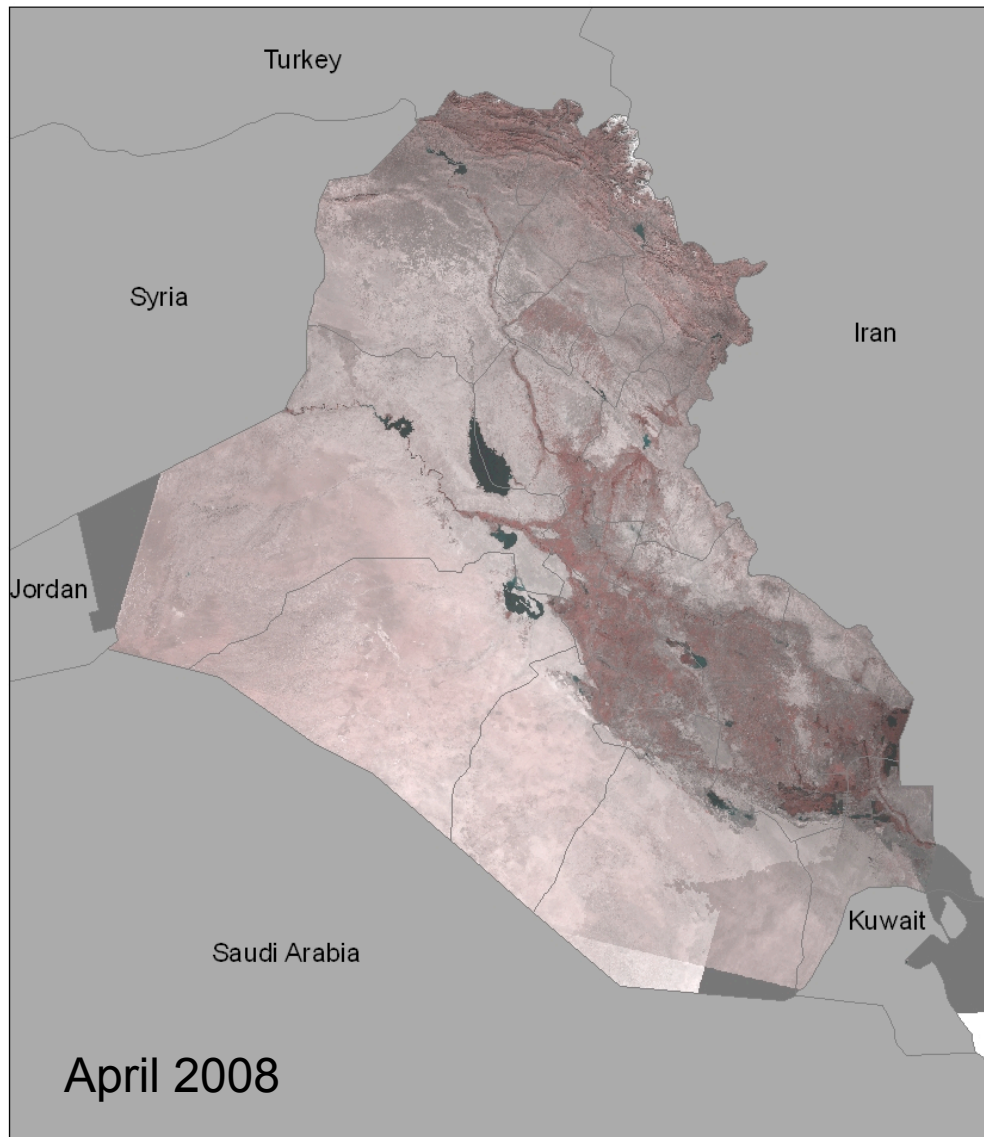
Data source: Digital Globe Quickbird Panchromatic  
Data provide by: National Geospatial Intelligence Agency  
In support of: USDA/EAS/OGA/IPAD





# Production Statistics: Area

GDA Corp: SASR Mosaic



GDA Corp. Scene-based  
Dominant Crop (SBDC) mask

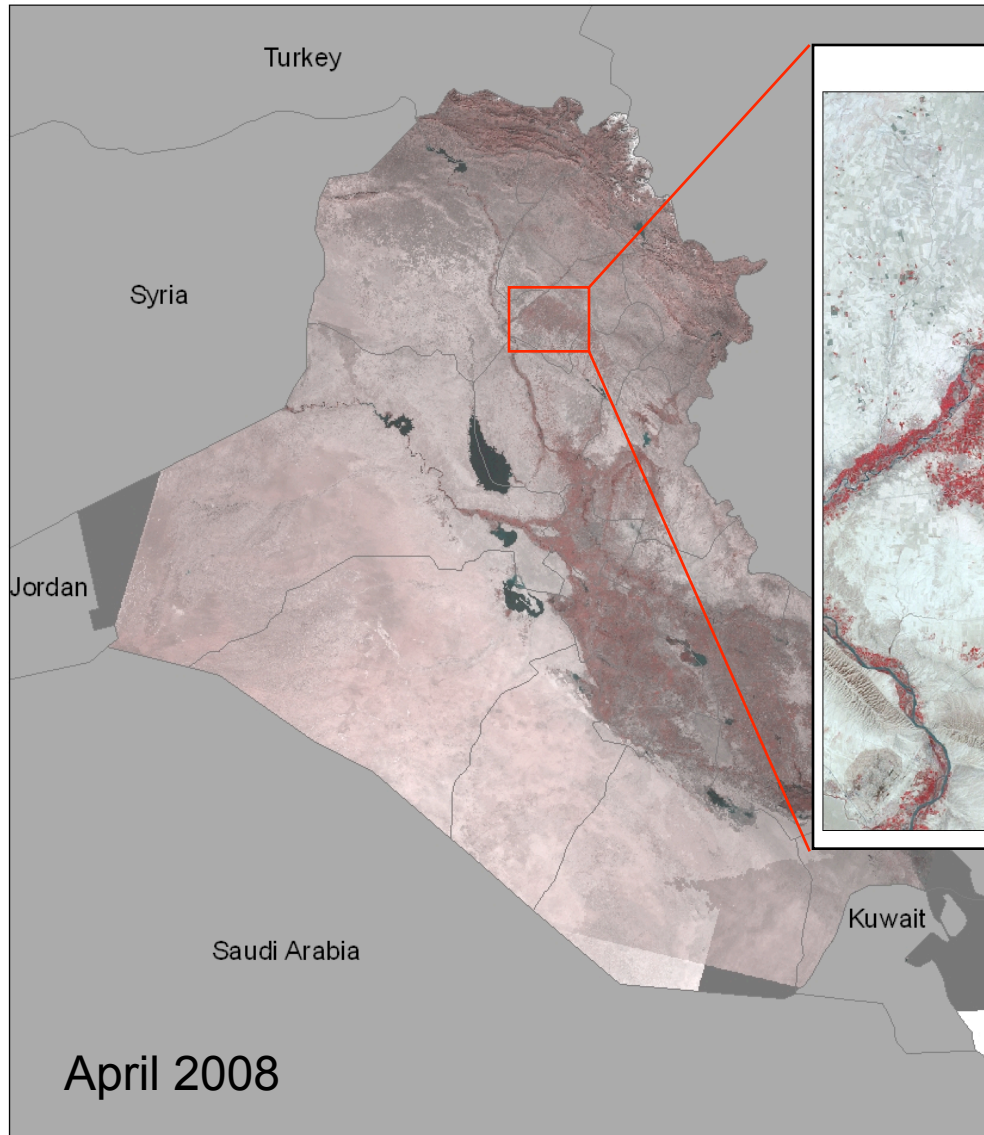


Data Source: AWIFS IRS P-6  
Data provided by: National Geospatial Intelligence Agency  
Supporting: USDA/FAS/OGA  
International Production Assessment Division

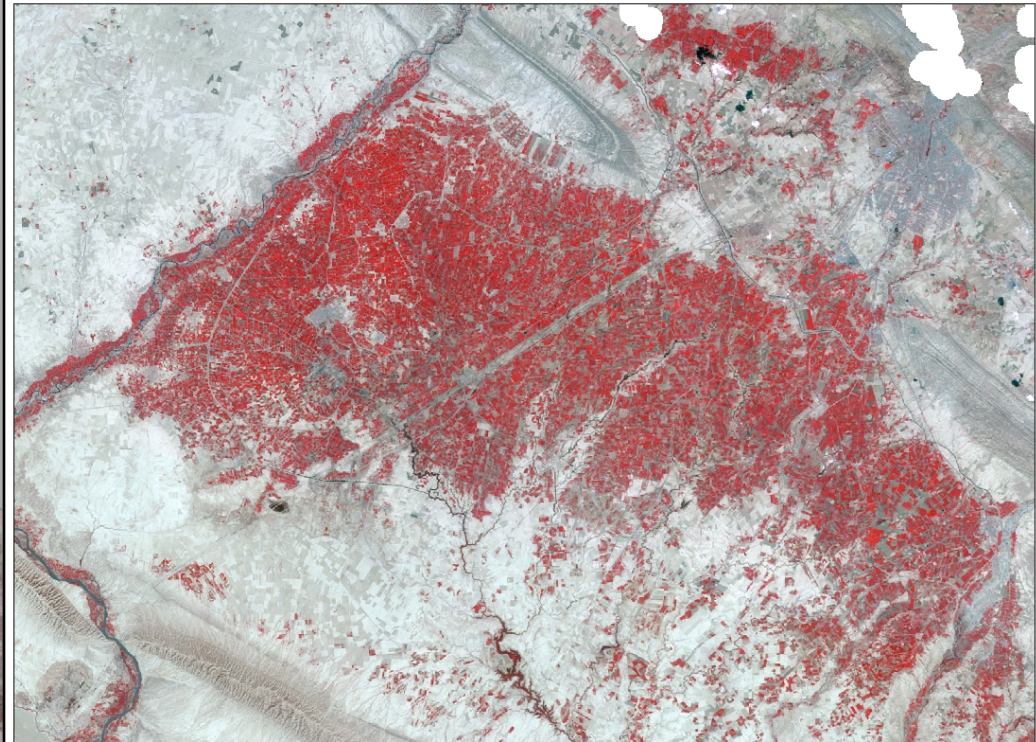


# Production Statistics: Area

GDA Corp: SASR Mosaic



GDA Corp: Scene-based Dominant Crop (SBDC)



GDA Corp. Scene-based  
Dominant Crop (SBDC) mask



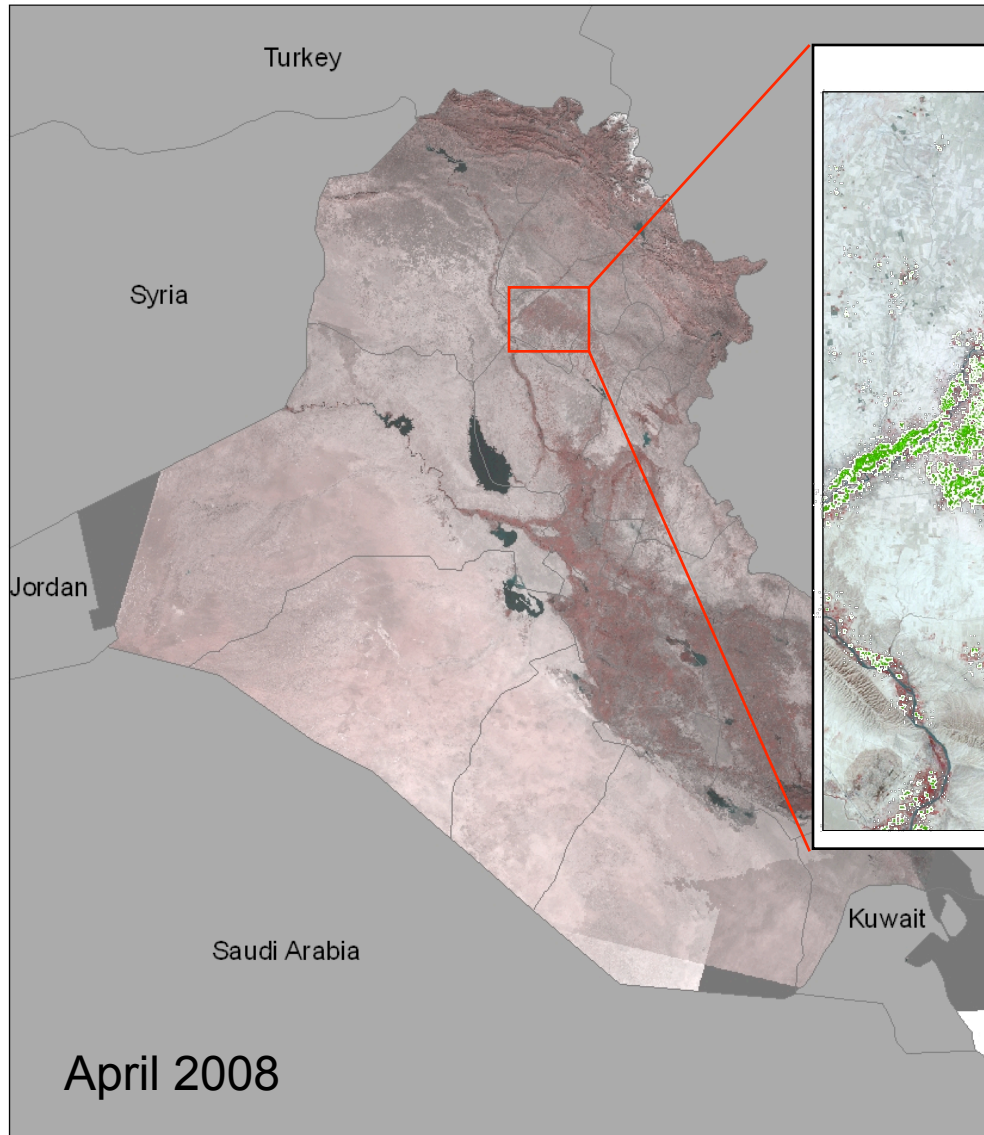
Data Source: AWIFS IRS P-6  
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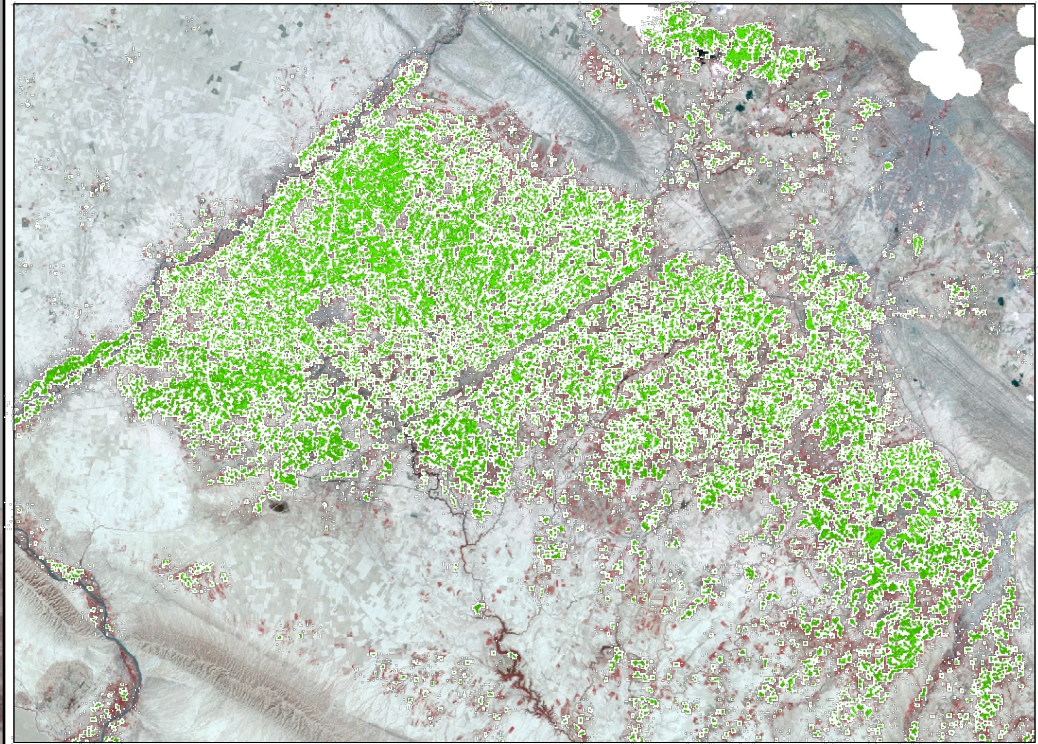


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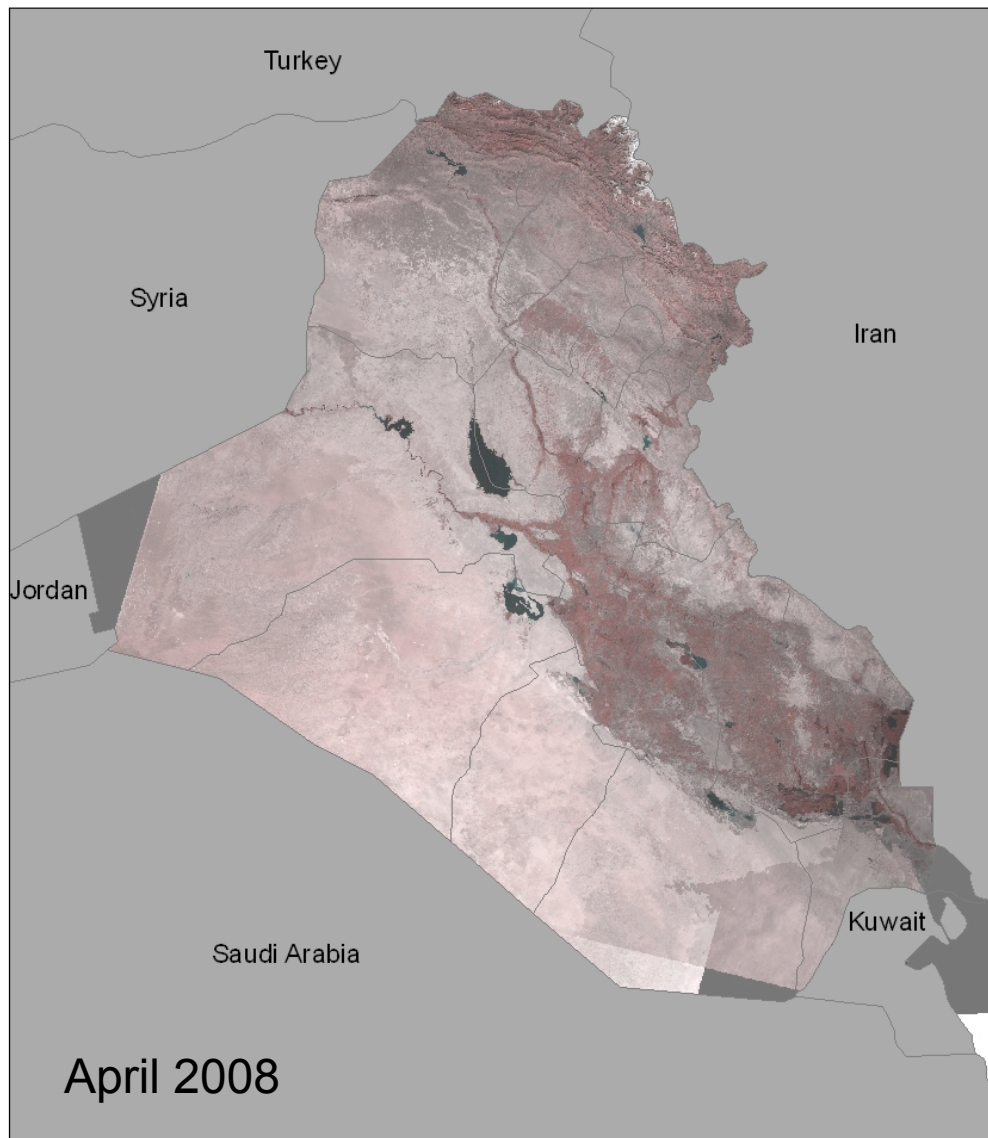


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# Production Statistics: Area

GDA Corp: SASR Mosaic



USDA Produced Image Classification  
(Dominant Crops)

Classification Trees



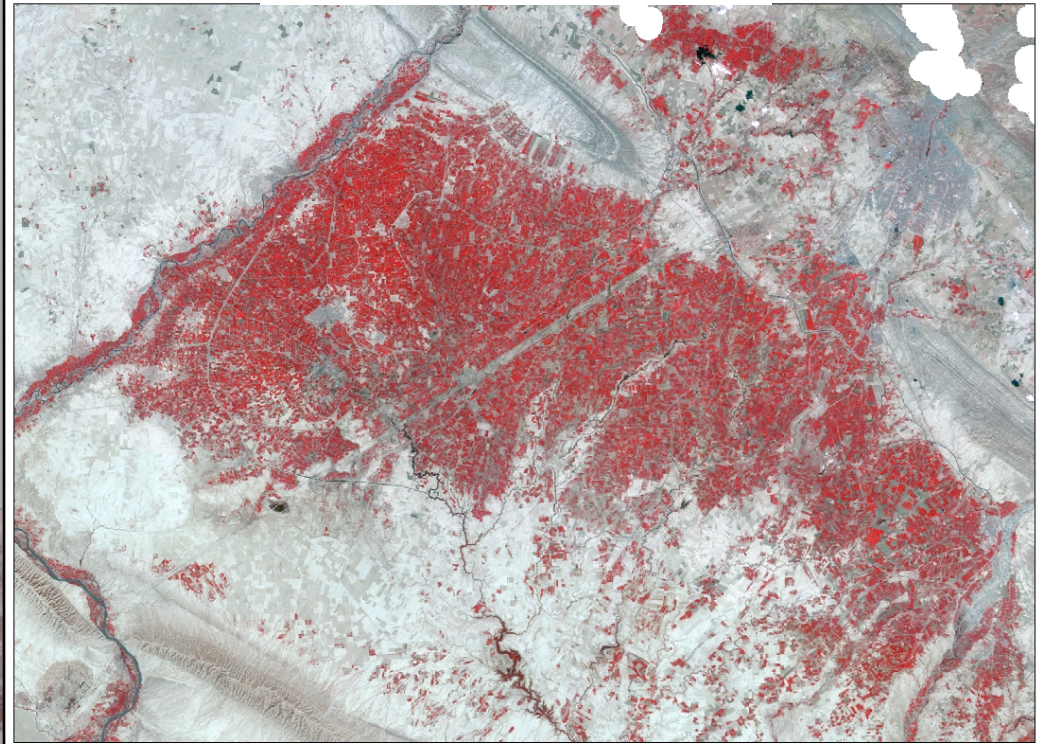
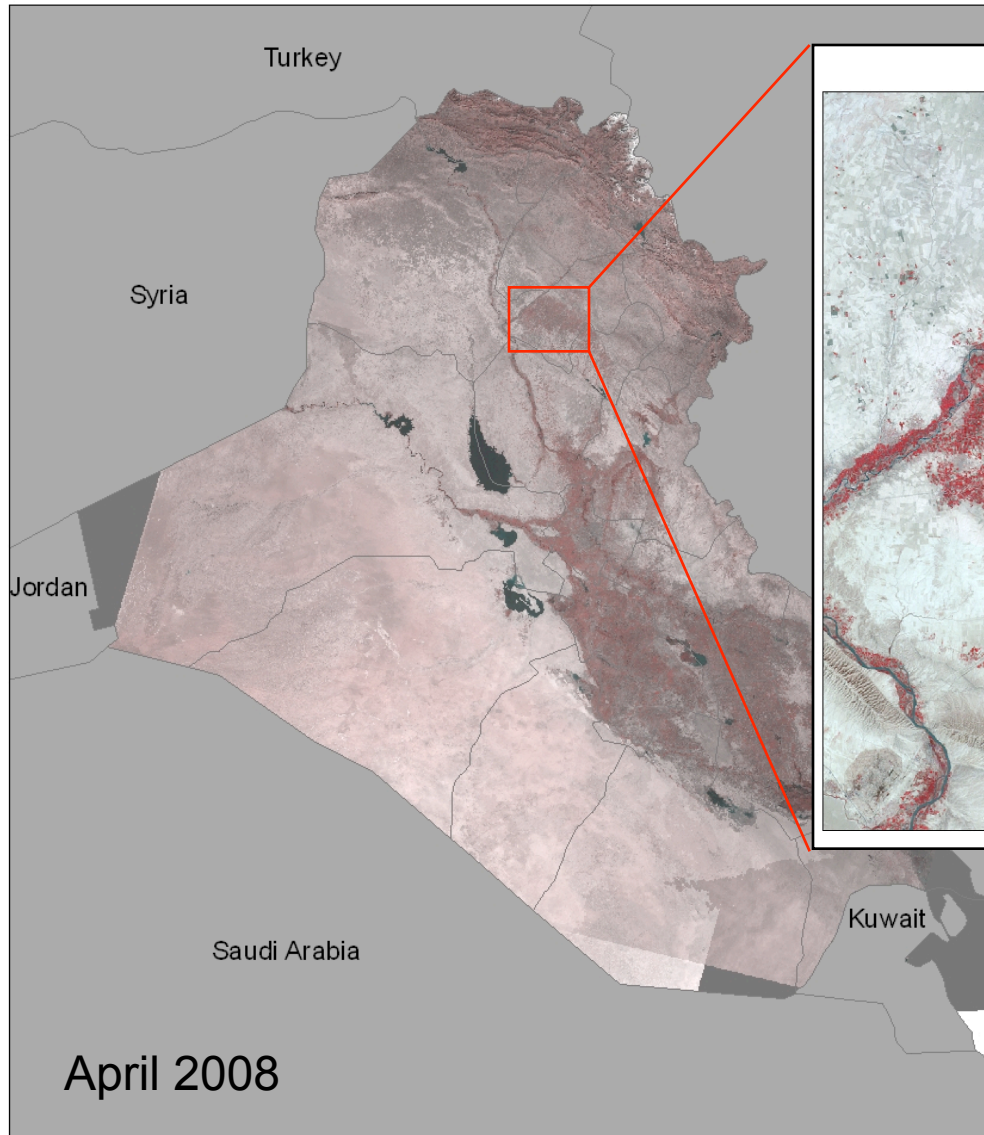
Data Source: AWIFS IRS P-6  
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GDA Corp: SASR Mosaic



USDA Produced Image Classification  
(Dominant Crops)

Classification Trees



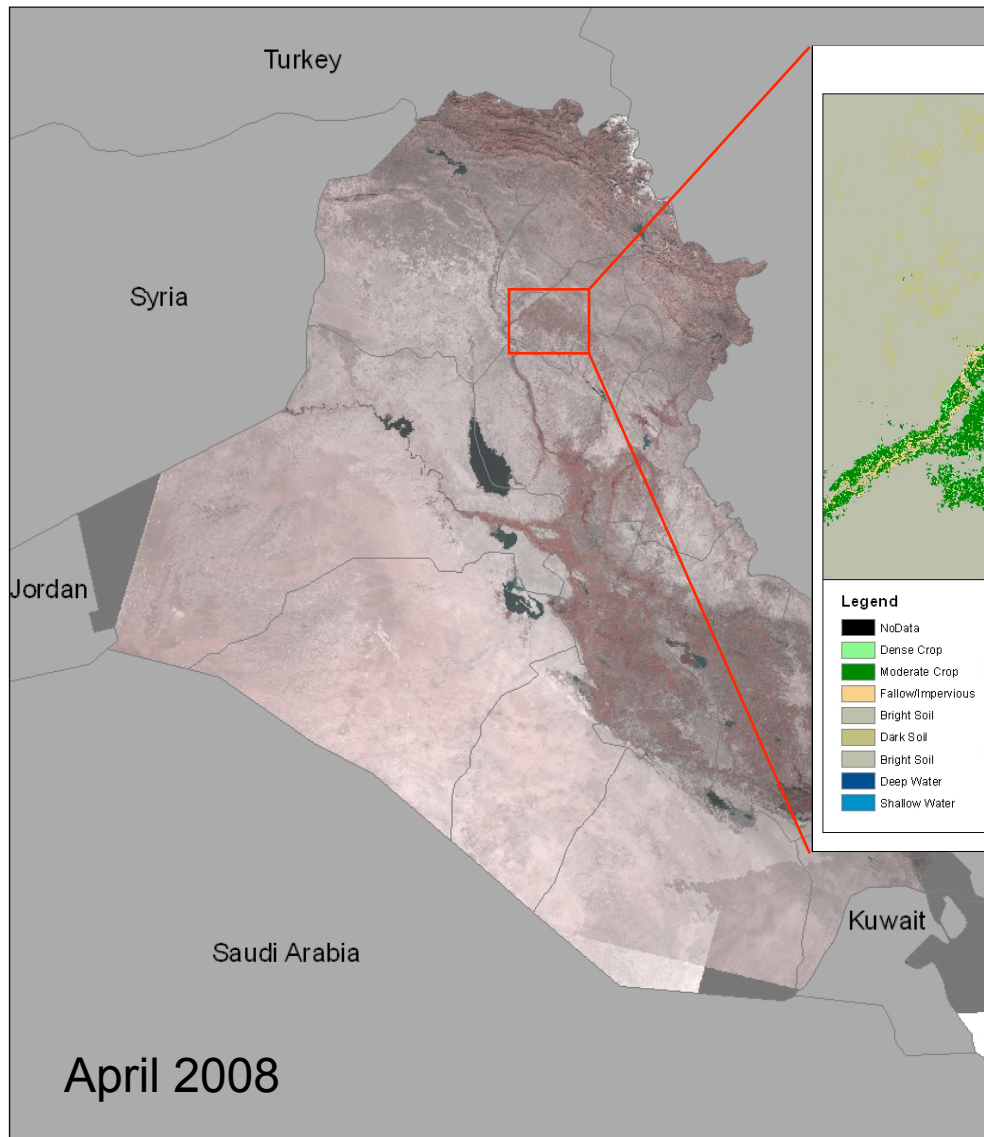
Data Source: AWIFS IRS P-6  
Data provided by: National Geospatial Intelligence Agency  
Supporting: USDA/FAS/OGA  
International Production Assessment Division



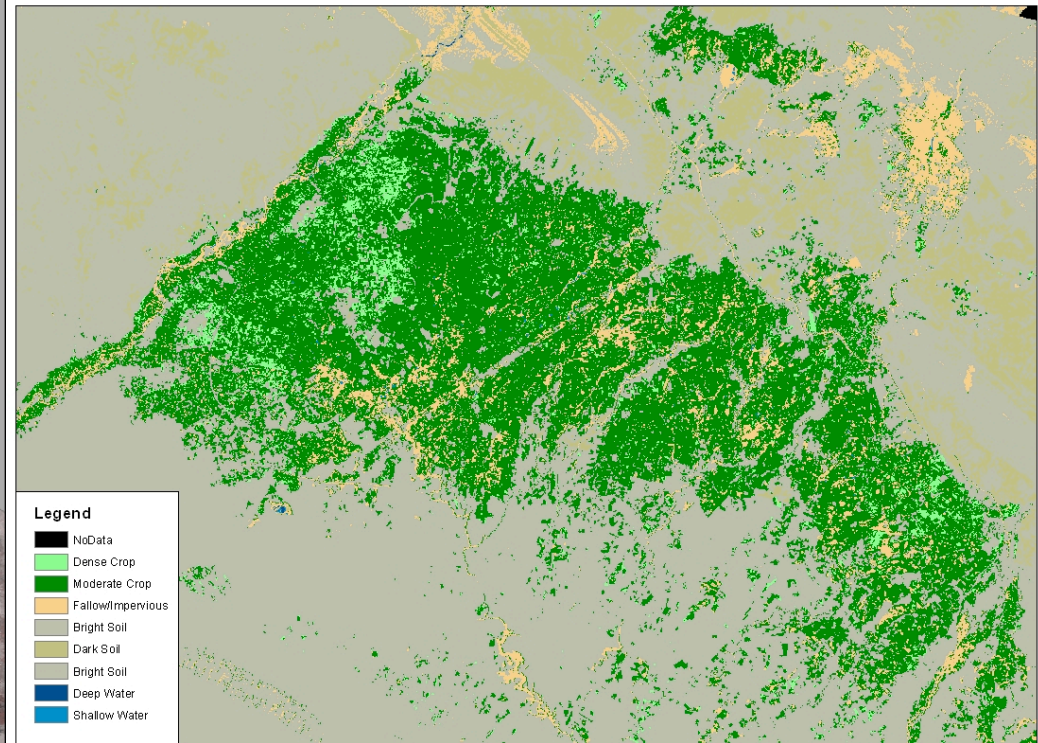


# Production Statistics: Area

GDA Corp: SASR Mosaic



Scene-based Classification: Decision Tree



USDA Produced Image Classification  
(Dominant Crops)

Classification Trees



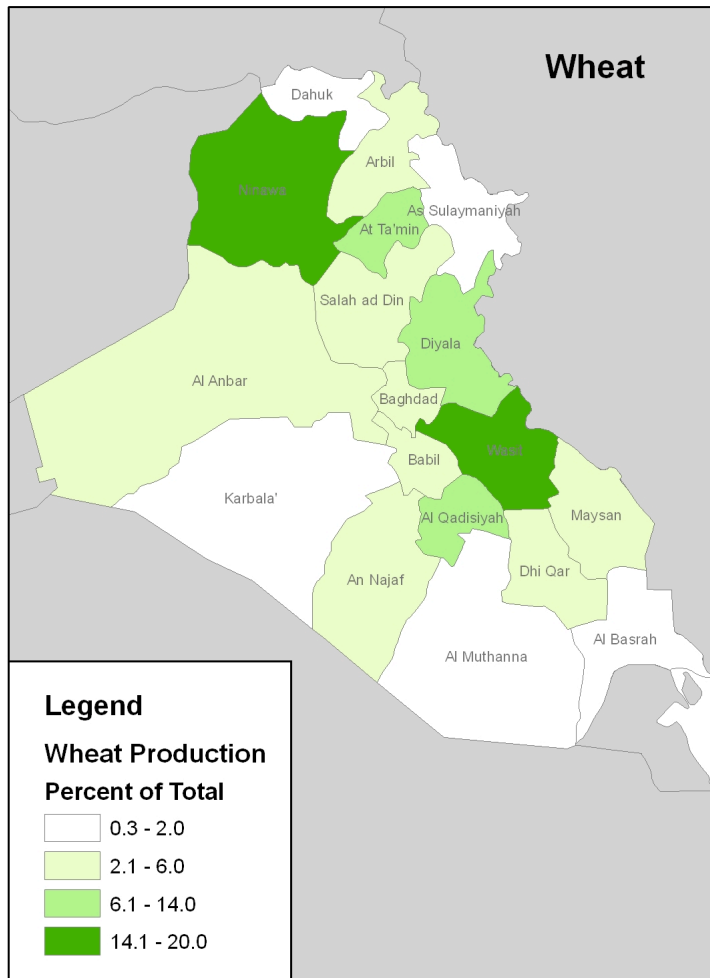
Data Source: AWIFS IRS P-6  
Data provided by: National Geospatial Intelligence Agency  
Supporting: USDA/FAS/OGA  
International Production Assessment Division





# Production Statistics: Area

## 5-Year Average

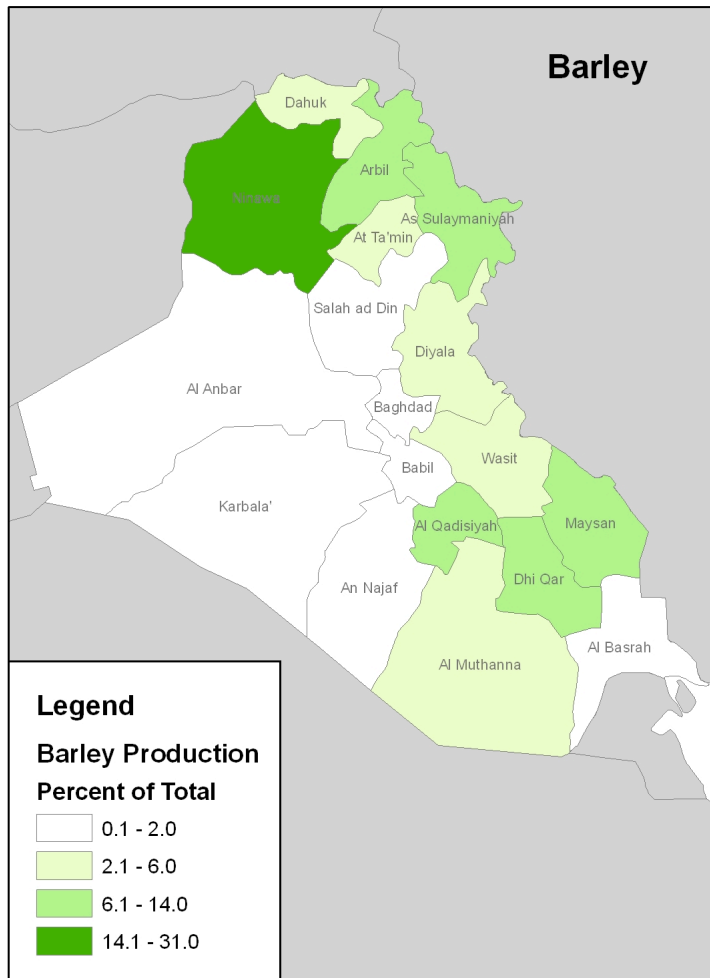


Barley Area Forecast: MY 2008/09 (Million Hectares)										
Region	Governorate	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	5-Year Average	Difference 5-Year Avg
North	Arbil	0.110	0.149	0.086	0.271	0.243	0.250	0.022	0.161	-86.5%
	Dahuk	0.032	0.039	0.027	0.037	0.041	0.050	0.009	0.034	-72.2%
	As Sulaymaniyah	0.122	0.043	0.052	0.125	0.108	0.110	0.051	0.087	-41.2%
	Ninawa	0.653	0.525	0.529	0.614	0.595	0.615	0.029	0.509	-94.2%
Central	At Ta'min	0.025	0.038	0.010	0.023	0.029	0.030	0.015	0.024	-38.4%
	Diyala	0.023	0.095	0.038	0.037	0.035	0.035	0.034	0.042	-19.5%
	Salah ad Din	0.016	0.030	0.039	0.028	0.015	0.015	0.020	0.023	-15.6%
	Baghdad	0.005	0.033	0.005	0.008	0.006	0.005	0.009	0.010	-9.1%
	Babil	0.012	0.017	0.021	0.020	0.024	0.025	0.020	0.020	2.1%
	Wasit	0.048	0.047	0.055	0.069	0.063	0.060	0.053	0.056	-6.8%
	Al Qadisiyah	0.043	0.085	0.078	0.077	0.080	0.080	0.080	0.075	7.3%
	Karbala	0.002	0.001	0.002	0.002	0.003	0.003	0.002	0.002	-6.1%
	Al Anbar	0.002	0.003	0.003	0.002	0.003	0.003	0.003	0.003	2.4%
	An Najaf	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.002	-8.3%
	Al Muthanna	0.023	0.033	0.038	0.023	0.027	0.025	0.028	0.028	-0.9%
	Dhi Qar	0.043	0.043	0.064	0.082	0.075	0.075	0.059	0.063	-6.4%
South	Maysan	0.030	0.038	0.066	0.071	0.065	0.065	0.060	0.056	6.6%
	Al Basrah	0.009	0.007	0.006	0.005	0.006	0.005	0.007	0.006	4.1%
<b>Total</b>		<b>1.20</b>	<b>1.23</b>	<b>1.12</b>	<b>1.50</b>	<b>1.42</b>	<b>1.45</b>	<b>0.50</b>	<b>1.20</b>	<b>-58.2%</b>

Wheat Area Forecast: MY 2008/09 (Million Hectares)										
Region	Governorate	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	5-Year Average	Difference 5-Year Avg
North	Arbil	0.133	0.235	0.099	0.117	0.127	0.120	0.017	0.121	-85.6%
	Dahuk	0.122	0.129	0.098	0.102	0.091	0.100	0.026	0.095	-72.3%
	As Sulaymaniyah	0.163	0.109	0.070	0.153	0.120	0.120	0.070	0.115	-39.2%
	Ninawa	0.751	0.450	0.613	0.551	0.489	0.464	0.027	0.478	-94.3%
Central	At Ta'min	0.179	0.183	0.160	0.195	0.141	0.205	0.104	0.167	-37.9%
	Diyala	0.063	0.094	0.087	0.109	0.113	0.106	0.079	0.093	-15.0%
	Salah ad Din	0.110	0.125	0.107	0.110	0.108	0.107	0.094	0.109	-13.5%
	Baghdad	0.043	0.055	0.043	0.060	0.059	0.048	0.053	0.052	2.9%
	Babil	0.047	0.083	0.049	0.068	0.068	0.065	0.064	0.064	1.4%
	Wasit	0.165	0.159	0.148	0.166	0.157	0.164	0.148	0.158	-6.4%
	Al Qadisiyah	0.058	0.065	0.093	0.094	0.095	0.092	0.090	0.084	7.7%
	Karbala	0.006	0.005	0.006	0.007	0.004	0.002	0.004	0.005	-10.0%
	Al Anbar	0.036	0.033	0.043	0.035	0.056	0.057	0.044	0.043	1.1%
	An Najaf	0.046	0.045	0.046	0.048	0.045	0.050	0.043	0.046	-7.6%
	Al Muthanna	0.006	0.017	0.018	0.012	0.012	0.011	0.012	0.013	-3.4%
	Dhi Qar	0.020	0.020	0.032	0.046	0.061	0.059	0.035	0.039	-11.2%
South	Maysan	0.055	0.063	0.077	0.088	0.087	0.094	0.086	0.079	9.1%
	Al Basrah	0.013	0.016	0.016	0.014	0.017	0.017	0.016	0.016	4.6%
<b>Total</b>		<b>2.02</b>	<b>1.89</b>	<b>1.81</b>	<b>1.97</b>	<b>1.85</b>	<b>1.88</b>	<b>1.01</b>	<b>1.78</b>	<b>-42.9%</b>

# Production Statistics: Area

## 5-Year Average



Barley Area Forecast: MY 2008/09 (Million Hectares)										
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	Babil	0.012	0.017	0.021	0.020	0.024	0.025	0.020	0.020	2.1%
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# THANK YOU!

## CONTACT INFORMATION AND QUESTIONS AND ANSWERS

### **Iraq Operational Agricultural Monitoring Project:**

United States Department of Agriculture (USDA)

Foreign Agricultural Service (FAS)

Office of Global Analysis (OGA)

***International Production Assessment (IPA)*** Division



**Presenter:**  
**J. Edward Kunz, GISP**  
Geospatial Program Manager  
ASRC Management Services  
[ed.kunz@asrcms.com](mailto:ed.kunz@asrcms.com)

**Sean Griffin**  
Remote Sensing Crop Analyst  
Supporting USDA/FAS/OGA/IPA  
[sean.griffin@asrcms.com](mailto:sean.griffin@asrcms.com)



Photo by Dr. Curt Reynolds